Computers and Privacy

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Three articles on the promise and threat of computers by Robert M. Fano, L. Alan Kraning, and Carla Vogt

Technology Review

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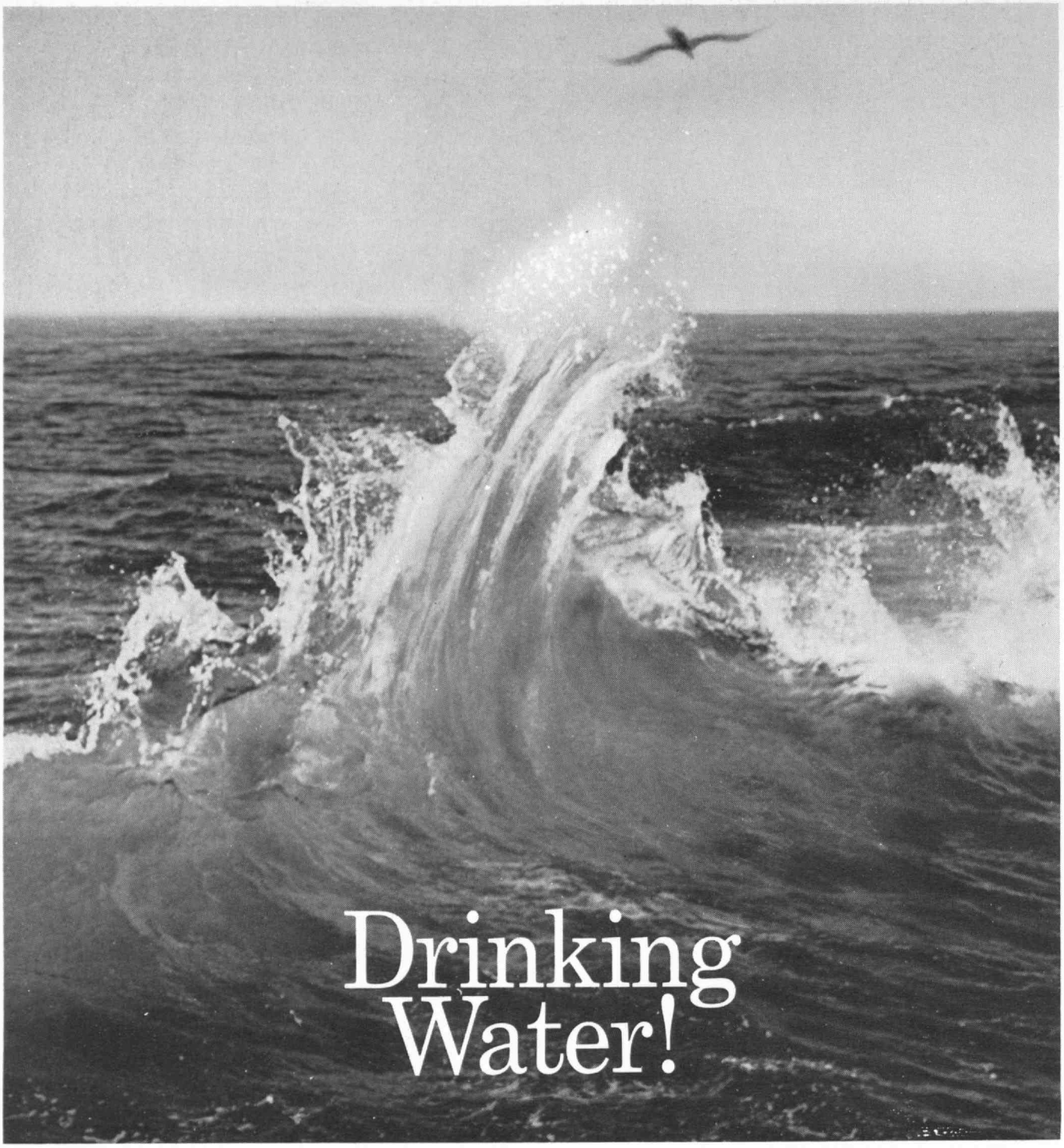

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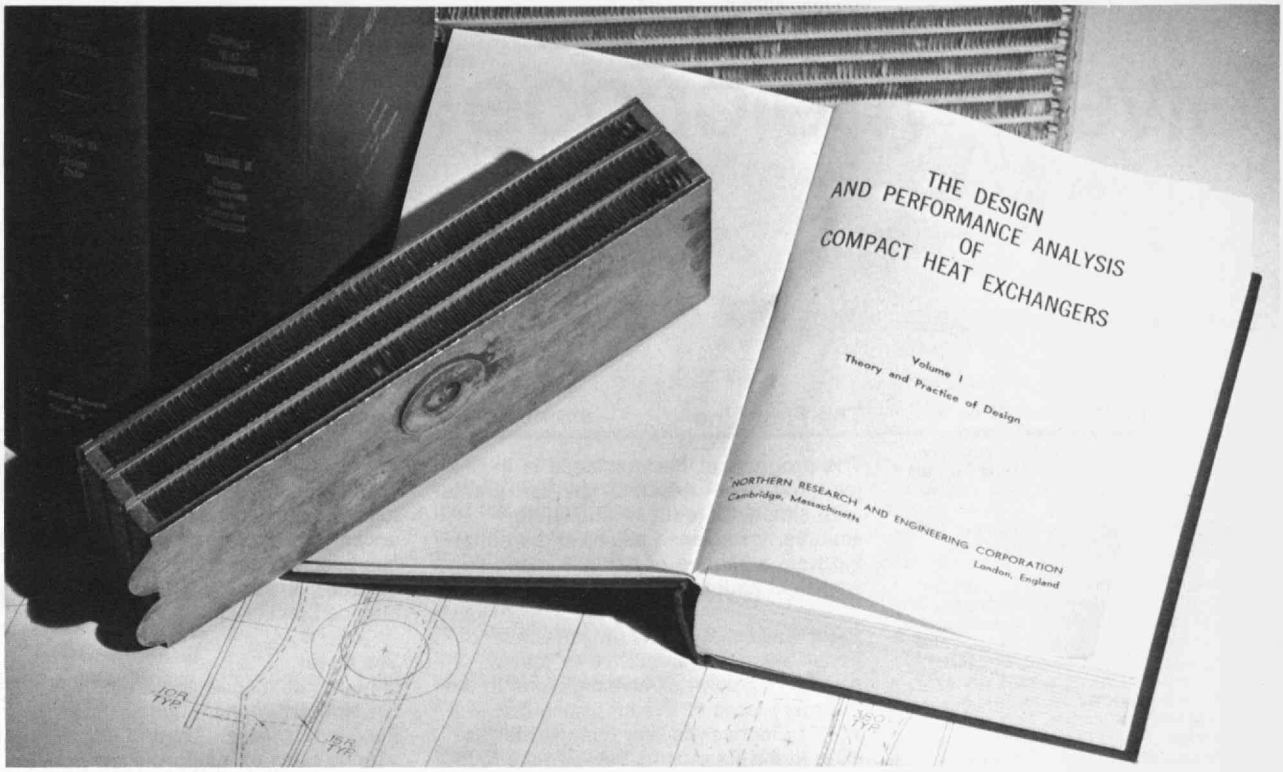

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The First Line

The progress of basic science is in triple jeopardy. The hazards are far greater than simply its reduced financial resources, for science seems to be suffering from a change of national mood as well as of national economics.

Peter Gwynne's report on N.A.S.A.'s Lunar Science Conference to review Apollo 11 moonrock investigations in the February issue of this magazine *(pp. 16-17)* emphasizes one remarkable feature: in the six months between the flight of Apollo 11 and the N.A.S.A. conference in Houston early this year, man's knowledge of lunar geology made an almost infinitely large advance. In these days, when it is customary to note the changing speed of change, that may seem hardly worthy of note. But such spectacular scientific advance remains the exception, not the rule. No sudden aberration is likely in the quest for understanding how a chain of neurons can become intelligent. Lest we be distracted by the fast, we must emphasize the slow.

The new word today is "relevance." We are looking for solutions to real problems —to clear the air and water, to contain oil spills, to improve urban life, to reduce the cost of housing, to build a safer car. These are real needs, worthy of the most aggressive technology. But they should be recognized as technology, not science. Concentrating solely upon such immediate problems may leave us unprepared to truly solve them.

A third threat to basic science arises unexpectedly out of circumstances which almost surely should benefit it: the effort to define and control America's military commitment. Congressional action requires the Pentagon to support only research which has clear relevance to military missions. The pathetic consequence is that many M.I.T. faculty, whose programs have been wisely funded for many years by military agencies willing to invest in basic knowledge, must now prove that their work has the military relevance to which in previous years they sought to be uncommitted.

Patrick P. McCurdy, Editor of *Chemical and Engineering News,* has wisely pointed out that basic, apparently irrelevant studies are the first to be forfeited in an age of financial stringency. There are other powerful factors, as well, which today conspire against the deliberate accumulation of basic knowledge which has been the background for three decades of world prosperity. The future may be bleaker than we know.—J.M.

The Cover
"My late colleague and mentor, Professor Norbert Wiener," writes Robert M. Fano in this issue, "used to illustrate with various tales of magic the dangers inherent in delegating decisions to computers. . . . Computers, like magic, are literal-minded; it is our responsibility to make sure that what we ask for is indeed what we want."

The cover illustration is a photograph of Norbert Wiener in which densities are translated into two-digit numbers, written by a digital plotter. It was produced by H. Philip Peterson and Robert A. Freedman of the Visual Data-Processing Laboratory of Control Data Corp.

The Photographs in this Issue
The photographs on pages 24, 32, and 40 are the work of Pamela Schuyler, a new student in the M.I.T. Creative Photography Laboratory; they were made especially for the *Review.* The photographs included with Jeffrey Ingram's article (page 62) are the work of Jeffrey M. Reynolds, who studied with Professor Minor White in the Creative Photography Laboratory while taking his bachelor's degree in mechanical engineering, 1969.

Cambridge Project: Correction
We regret that our February issue *(p. 74)* incorrectly listed Edwin B. Newman, Professor of Psychology at Harvard and chairman of the Harvard participants in the Project, as Edward Newman, and as Chairman of the Project's Joint Advisory Board. In addition, we said that "Harvard withdrew" from the Project; whereas the Project itself, in January, dropped a request for "extraordinary action" that would have given Harvard joint institutional responsibility with M.I.T. over the project. Many Harvard faculty are participating in it under the normal terms for outside grants.

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for
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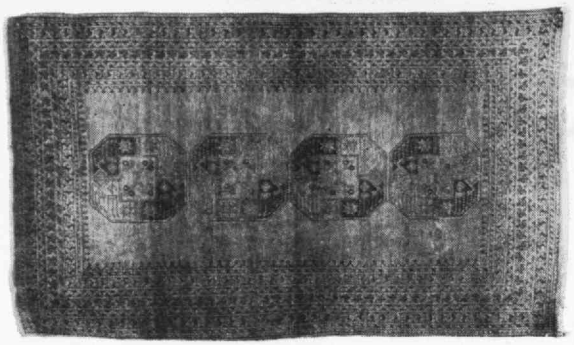

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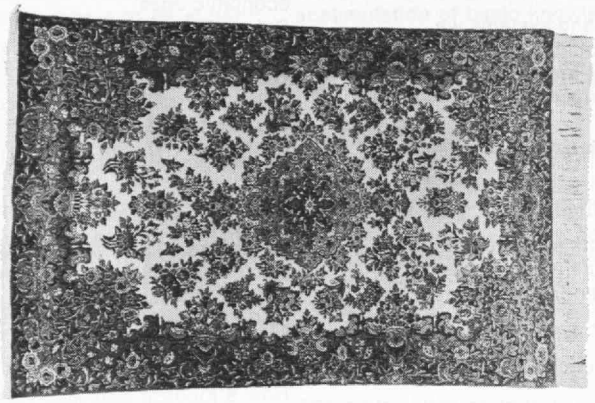

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"I have a feeling," says one fish-farm research leader, "that we should be asking for economic advice now. We've reached the point where we need someone to advise us on what experiments to do next."

Cautious Optimism on Fish Farming

Farming the sea is one of those futuristic goodies that science writers love to extoll. The trouble is that as it becomes practical, we have to climb down from some of the more lyrical visions with which its prophets have embellished the dream.

Like other kinds of farming, its success depends on the nitty gritty of economics, not on the food potential of fish. Either the sea farmer delivers a product people will buy at a price that allows reasonable profit, or aquaculture will be a chimera.

For such luxuries as oysters or mussels, sea farmers already do this in a number of countries. But the hope of developing a significant new source of protein means working with fish. It also means an industry with no assured, high-price market, with as yet no reliable cost estimates, and with basic uncertainties in the art of fish husbandry. The more biologically feasible fish farming becomes, the more these subsidiary factors intrude upon the aquaculturists' dream.

You run into this in Britain where some of the most advanced fish farming research is underway. Britain has a good prospect, in this decade, of developing commercial farming for some form of flatfish such as plaice, sole, or turbot. However, the fish farming researchers smile wryly at propaganda that has colored their field.

Theoretically, you can get some rather impressive forecasts. For example, the Phillippine Government a few years back identified a million and a half acres of mangrove swamps that might be used to rear milkfish. One eminent oceanographer then figured these could yield the equivalent of the total United States fish landings on a yearly basis. His estimate said nothing about the cost of feeding the fish. It took no account of husbandry problems such as the effects of disease or stress on intensively farmed animals. It didn't even question whether the swamps would be the best place to farm fish. Yet these are the kinds of problems with which researchers in Britain are having to wrestle.

Their work runs along two complementary lines. The White Fish Authority has a development project in which it has been able to rear flatfish to eight-ounce marketable size in half the time fish grow that big naturally. Meanwhile, other laboratories are looking into factors affecting fish growth, fish genetics as an aid to selective breeding, disease, and other things fundamental to future fish farming.

Waters Natural and Nuclear

For nearly half a decade, the White Fish Authority has been raising fish in Britain's north. They have projects at the Hunterston nuclear power station in Ayrshire and on one of Scotland's picturesque lochs at Ardtoe in Argyllshire.

At Hunterston, Dover sole have been thriving in tanks fed with the warm water of the power station discharge. Instead of being an annoying source of thermal pollution, the water provides an ideal medium for the fish. They can tolerate the small amount of chlorine added to keep piping clean of marine organisms. The water's warmth, in turn, extends the fishs' growing period throughout the year. So they reach marketable size in 18 months compared to four to five years in the open sea.

Meanwhile, researchers at Ardtoe are seeing what they can do to foster growth under somewhat more natural water conditions. They work in an inlet separated from the loch by a dam with sluice gates. This helps control the salinity and temperature of their farm to some extent. Within this enclosure, they grow plaice in netted pounds on the bottom, in cages anchored to the bottom, and in floating tanks and cages of various types.

Their fish start out in nurseries. These are either tanks on shore or special floating cages. Then they are transferred to one of the husbandry units to grow up. They reach marketable size in two years, not significantly longer than at Hunterston.

Thanks to these encouraging experiments, there's no doubt that flatfish can be grown artificially in large quantities. And some of the researchers, such as Gordon Eddie, technical director of the Ardtoe work, think they have enough feel for costs to forecast that flatfish farming will be economically attractive within another few years. But even an enthusiast like Mr. Eddie admits it's still too early for him to guarantee that his past success will be repeatable over the long term. Indeed basic uncertainties undermine his optimism.

For one thing, ichthyologists know next to nothing about marine fish diseases. Donald Smith, Ardtoe's principle officer, calls this unknown the main obstacle to practical fish farming. Under the intensive husbandry at Hunterston or Ardtoe, disease could wipe out an entire stock.

Questions of Economics

Then too, what really are the costs? At present, fish larvae are fed the nauplii of Artemia, a brine shrimp. Then they are switched to a cultivated worm, and finally to food prepared mainly from fish wastes. It's nourishing food, yet not as cheap as fish farmers would like for commercial operation.

Costs will also depend partly on farm conditions. It may be that the present tanks or enclosed loch cages would not be the most practical farm in the long run. And would it be cheaper all around for commercial nurseries to supply baby fish to the farmers, or should the farmers do the entire rearing job? What are the best densities at which to raise fish? Too much crowding could inhibit growth, while too much space would be wasteful. Also, what are the best fish species?

Scientists looking into the basics of fish farming find such questions sobering. Much of this work goes on at the Fisheries Laboratory, run at Lowestoft by the Ministry of Agriculture, Fisheries, and Food.

Dr. D. H. Cushing, who heads the biology section at Lowestoft, says fish farming research suffers from too much enthusiastic publicity. He has little doubt about its ultimate practicality. Yet he's reluctant to predict when that will be. "I have a feeling, although it's only intuitive, that we should be asking for economic advice now," he says. "We've reached the point where we need someone to advise us on what experiments to do next, on what information to get so that meaningful assessments of probable

costs can be made." He agrees with Mr. Smith that disease is a disquieting uncertainty. In the open sea, it's much less important than the attacks of predators. So marine biologists have not studied it much. Yet in enclosed fish farms it could be devastating. Psychological effects, such as those of crowding, may also be important. For example, when plaice are small they get antagonistic to each other if crowded too closely. Yet, to judge from experiments at Lowestoft, they will tolerate being stacked on top of one another after they have grown to a certain size.

The Lowestoft scientists don't yet know when in the life cycle this behavioral switch occurs. Nor do they know whether it is a normal pattern, or a stressful one induced by fish farming conditions and detrimental to the fish in the long run. However, workers at Ardtoe, too impatient to wait for laboratory scientists to explore these questions, have begun stacking plaice on their farm. They pile them five or six deep, pouring food on top of them. So far the fish seem to grow quite happily, Dr. Cushing said. But he noted that the "let's-try-anything" approach at Ardtoe, while perhaps getting quick results, does not always shed light on the fish biology involved.

There are subtleties to that biology which could mean a lot to fish farmers. Lowestoft is studying optimum conditions of water temperature and oxygen content. What they find will help growers decide how finely they have to control such conditions in fish farms. So far, experimental fish seem unexpectedly tolerant of temperature changes, such as that brought on by a sharp frost. They begin to die if dissolved oxygen falls below about 65 per cent of saturation. However, 75 per cent seems a safe lower limit, from data gathered so far. This may mean that growers could save on the cost of pumping fresh sea water through tanks. This now is done at a rate to maintain oxygen saturation.

At this point, too, it's hard to say just what form future fish farms may take. The tanks and enclosed lock of Hunterston and Ardtoe work well in experiments. But would large fish farms require something like an enclosed bay? Dr. Cushing thinks the farming will most likely be done in tanks or in gravel-bottomed basins or ponds. It you let fish go into a large area, you run into costs of boats and gear to catch them, he notes. In small ponds, you could walk in and pick them up.

Adapting the Fish

Lowestoft is also looking for better fish to farm. Alan Jones made a study of several flatfish and found that, pound for pound, turbot might be the biggest money maker. It grows faster than the others. It will eat trash fish—unwanted fish brought in by trawlers—whereas sole or plaice are more finicky.

Then too, it may be possible to breed a better stock than nature provides. Geneticist Colin Purdon is trying to develop pure inbred strains which could then be crossed to produce vigorous hybrids. He uses an unusual short cut. He fertilizes eggs with sperm that has been made genetically inactive by radiation. By delicate techniques, including precisely timed cold shock, he can induce these eggs to develop. It's a kind of parthenogenesis. Most of the embryos are deformed. But a few come through as apparently normal females. In this way, he can, within a couple of generations, get an inbred strain that would require 14 generations by normal breeding methods.

Meanwhile, John Riley and Graham Thacker are experimenting with normal crosses between fish such as plaice and sole, or plaice and flounder. Some of these fish have traditionally been classified in different genera, let alone different species, but they cross so readily in the laboratory that it begins to look as though they are much more closely related than their classification suggests. Here again, vigorous hybrid may be found that would be a better farm fish than any nature has provided.

Like the cut-and-try work at Hunterston and Ardtoe, these more basic researches do point to practical fish farming on some scale, probably in this decade. But Lowestoft workers wince when the White Fish Authority estimates that it would take "only" three square miles of intensively farmed sea to raise the equivalent of Britain's total annual white fish catch. Three square miles of what, they ask, with what fish at what cost? And with just what really hard facts would you attract investors to set up sea farms on this scale?

While John Riley admits to being "cautiously optimistic," he stresses the "cautious." "The biological feasibility of farming plaice and sole has been established. But the economic feasibility of the scheme is unknown," he says.

Researchers such as Mr. Riley point out that they can speak at first hand only of British conditions. They know that some speciality fresh water fish, such as trout, are being farmed. They have read of Asian fish farming, such as raising fish in rice paddies during the flooding cycle. Yet they also know that, whatever the regional differences, making marine fish farming pay anywhere will take a lot of hard work and detailed study. "Be skeptical of what you read about fish farming," Mr. Riley advises, "We have a long way to go."

Robert C. Cowen, Science Editor of the Christian Science Monitor, *is writing from the* Monitor's *London office in 1969-70. He is a Past President of the National Association of Science Writers, and he received the American Chemical Society's Grady Award late last month.*

Washington Report
Victor Cohn

Even given no new federal programs other than those President Nixon has already proposed, federal tax receipts in 1975 will still exceed spending only by $22 billion. This is far from enough to clean up the environment, rejuvenate cities, uplift the poor and black—and support science

Only In Nonomura

"We want to spray your swamps," says the peace mission man to the Prince of Nonomura in Art Buchwald's new play.

"But that's dangerous," the prince objects.

"It has been declared dangerous for the United States, but not for the rest of the world," the peace man replies.

A terrible exaggeration, of course. As Mr. Buchwald admits, only 50 per cent of what he writes is regarded as true in official Washington.

And everyone knows that is no such country as Nonomura.

Another Thin Year in the Lab

The figures are now in on proposed federal support of science in fiscal 1971 (the year starting next July). It will be another thin year in the lab.

Total obligations for research in physical, biological, medical, and social sciences will increase from an estimated $5.5 billion to $5.8 billion, up 5 per cent. But will research be up 5 per cent? Not at all.

First, obligations (the amounts of money agencies are authorized to commit) run ahead of spending; in austere times, a good deal of obligated money never gets spent. Actual fiscal 1971 spending, by President Nixon's new budget, would go up only 1.8 per cent.

Second, Congress for four years has been severely cutting Presidential research requests. Who can say what will happen to these figures as this spring and summer go by?

Third, there is inflation. Even if Congress should vote every cent the President asks, Presidential Science Adviser Lee DuBridge estimates, research buying power will be down 3 per cent. People in many fields, looking back a few years, say actual research is *already* down about 20 per cent.

A few more specific figures. Academic research obligations (commitments for colleges and universities, not counting contract labs) would increase by $114 million, or 8 per cent, from $1.418 to $1.532 billion. This would include a proposed $511 million for the long-starved National Science Foundation (comparable 1970 figure: $461 million). But here again actual fiscal '71 academic spending will be up a bare $26 million.

There are some victories. That 8 per cent increase in commitments and the renewed attempt to break the $500 million barrier for N.S.F. are a tribute to hard work and hard talking—some of it to the President, some to the powerful Bureau of the Budget—by DuBridge and N.S.F. Director William McElroy. The National Institutes of Health would get a 7 per cent increase (from $1.439 to $1.542 billion), about half in-house (supporting National Institutes of Health labs), half out-house (supporting projects at universities and hospitals—not scatology). Most of the increased N.I.H. spending would be in cancer, heart, and lung diseases.

But a little more detailed examination of the budget reveals that *overall* federal fiscal '71 health research spending would increase by only 3 per cent. Total federal health spending—excluding the giants like Medicare and Medicaid that provide direct health care to the poor and aged—would go up only 2 per cent. The National Institute of Mental Health, an agency with hugely successful new mental health clinic programs and an agency facing huge demand for new services to cope with youthful drug abuse, is slated for a $3.9 million cut, including research slashes.

Dr. DuBridge unhappily told a Washington audience that he does not expect anything better for science before mid-1972, and the picture is murky even then. Dr. Roger O. Egeberg, Assistant Secretary for Health, appeared before a Senate Subcommittee and agreed with a Democratic senator who sharply criticized Nixon Administration research cutbacks. The doctor even balked—temporarily—at reading a paragraph of his own testimony.

The paragraph opposed federally funded construction of new medical "demonstration, research and training facilities." "Someone else wrote it for me," Dr. Egeberg lamely offered. Art Buchwald couldn't have written a better line.

As for Mr. Nixon, he said when he ran for the Presidency, "In the name of economy, the current (Johnson) administration cut into muscle. The U.S. must end this depreciation of research and development in its order of national priorities."

Mr. Johnson indeed failed for too long to ask for a tax increase despite booming Vietnam spending, thus launching the nation into its present inflationary pickle. Then a Democratic Congress last year cut the belated income tax surcharge, which is now due to expire completely June 30. But Mr. Nixon consented and has to date uttered no new demand for its continuation, while repeating his campaign-style good words for science.

N.A.S.A.'s Graceful Loser

By and large, supporters of basic science and a wide range of national R. and D. are not weeping for the National Aeronautics and Space Administration, though the Administration is asking less than $3.4 billion for this glory-tinged agency for fiscal '71. This means nearly a half-billion dollar drop from fiscal '70—quite a splashdown.

Planetary and satellite programs will suffer, and here astronomers and astrophysicists are not cheering. But much of the cut will come from shutting down some facilities (Cambridge's Electronics Research Center, the Mississippi rocket engine test center), shrinking others, and curtailing or postponing lunar landings (only seven more instead of eight, stretched into 1974). Lunar scientists consider this a far saner schedule—they had been asking for something like it.

There were many other candidates for the space money. But federal R. and D. as a whole will not benefit. Total fiscal '71 research and development spending—including all the basic and academic research described above—will be $15.8 billion, down from $16.4. This will include outlays on defense, health, housing, commerce, transportation (including the S.S.T.), and the environment.

The upshot is alarming to persons who believe that R. and D. money is seed money for future growth. The federal R. and D. investment, in terms of per cent of the total budget, will be at its

lowest since the early 1960s, when the country was still catching up with the lesson of Sputnik. That event—so we thought—showed that both healthy research and healthy development on many fronts are needed to build future technology.

* * *

N.A.S.A. Administrator Thomas O. Paine Jr., wins the prize as Most Graceful Loser. He had the courage to present himself personally in Boston and Cambridge to announce the electronic center's closing. Then he thought he and the Budget Bureau were all agreed on a $3.5 billion N.A.S.A. budget. They were, but President Nixon ordered all agencies to find "a little bit more." Paine found $200 million, and appeared at a press conference on budget briefing day with a slide showing him on his back, sleeve rolled up, giving blood.

The astronauts saw it all coming. Wally Schirra of Apollo 7 is now making commercials for the American railroads, who seem to perceive some logical reason for his endorsement. He's also a businessman in Boulder, Colo. Frank Borman will be leaving the space program next summer, possibly to run for office in Arizona. William Anders is executive director of the National Aeronautics and Space Council, an anachronistic Presidential advisory body formally headed by Vice-President Agnew. Michael Collins is Assistant Secretary of State for Public Affairs—to explain U.S. policy to the public. If he's succeeded, we haven't heard about it.

Among earlier astronauts, John Glenn is still president of Royal Crown Cola's International Division. Scott Carpenter is vice president of a California oceanography firm. Rent-a-car. Rent-a-bed. Rent-a-general, as president, vice-president, board chairman, what you will. And now, naturally, rent-an-astronaut. Only in Nonomura . . . oops, America.

* * *

Back where we wrote about total federal research dollars *this* fiscal year, those numbers are just Budget Bureau guesses. At this writing (mid-February) Congress and the President still have not agreed on a Health, Education and Welfare appropriations bill, though the fiscal year is nearly three-quarters over. You may ask, "How can the government operate this way?" The answer is, "Not very well."

Such stranded agencies are authorized by Congress to spend at the previous fiscal year's level. Agency heads often try to spend even a bit less, where they suspect Congress may possibly slip in a cut. They certainly embark on nothing new or adventurous. There have been late appropriations before, but this sets a record. Only in America.

Education's New Pressure Group

A new force emerged during the struggle by Congress to add more than a billion dollars (mostly for education, partly for health training and research) to the Administration's H.E.W. bill. This force was an Emergency Committee for Full Funding of Education Programs, formed by some 90 national and local educational bodies. It included the big National Education Association, big city school boards, and other potent groups. It has been headed by able, roly-poly Charles W. Lee, a former congressional aid wise in the ways of the Hill.

This group joined with a similar but much smaller ad hoc medical lobby to hold one highly effective news conference and joint presentation. The educational groups relentlessly maintained their pressure; the health groups, having stated their piece, pretty much went home to await the results. In terms of getting things done in Washington, this was a mistake. Still, these trends—health organizations banding together to lobby, health groups joining education groups—are potentially significant. Add higher education and science, and it could be a potent combination.

It may be required. Budget Director Robert Mayo now warns that federal budgets may remain "austere" through 1975. *Given no new federal programs* other than those President Nixon has already proposed, he points out, federal tax receipts in 1975 will still exceed spending only by $22 billion. This is far from enough to clean up the environment, rejuvenate cities, uplift the poor and the black—and support science.

The fight, it seems plain, will be not to steal money from these "good causes" but to avoid a horrendously escalating defense budget and further whittle down present defense spending. This will be necessary because of what doctors (in trying to decide what tests are most important for a patient's diagnosis) now commonly call "Sutton's Law." Willie Sutton, asked why he robbed banks, replied, "That's where the money is."

In Washington, the Defense Department is where the money is. Congress cut around $5 billion out of its fiscal '70 funds. Mr. Nixon cut $5.8 billion to come up with a fiscal '71 proposal for $73.6 billion. But the full Pentagon design for national defenses—new undersea missile-delivery vehicles, fleet modernization, A.B.M.'s, hardened missile silos—would require large new sums in years immediately ahead.

Dr. George Rathjens of M.I.T., addressing the American Association for the Advancement of Science in December, forecast with great gloom that U.S.-Soviet strategic arms limitations will fail—because of continuing and "misguided" escalation on both sides. He forecast that the U.S. strategic arms bill, as a terrible consequence, may rise from $9 to $25 billion a year.

That's where the money is

A Brookings Institution team, determined to find it, is now drawing up an "independent" defense budget. One Brookings estimate foresees a defense budget level of a mere $60 billion by 1975. Unless something like this is achieved, the Brookings economists warn, the money will continue to flow to military hardware.

Only in America. Only in Russia. Only in Nonomura.

Victor Cohn is Science Editor of the Washington Post; *he formerly held a similar position with the* Minneapolis Tribune.

European Report
J. A. Redeker

Three European nations have agreed on a plan to develop ultracentrifuge plants which may ultimately supply most of the enriched uranium fuel for Europe's increasing nuclear power capacity

Ending the U.S. Uranium Monopoly

The governments of the United Kingdom, the Netherlands, and the German Federal Republic signed a treaty in February which ultimately may lead to ending the U.S. monopoly on enriched uranium supplied to a growing number of nuclear power plant operators. The draft treaty envisages a tripartite joint industrial venture: mass production of ultracentrifuges, enrichment of uranium hexafluoride (hex) in ultracentrifuges, and sale of the end-product—slightly enriched uranium.

Government approval of the terms of the ultracentrifuge agreement, which were reached last November, was announced in the three capitals involved on December 19. Under the agreement, the joint ultracentrifuge uranium-enrichment venture will get under way with an initial program for the production of 350 tons of uranium in two plants—one in the United Kingdom and one in the Netherlands. A tripartite Prime Contractor Organization and a tripartite Enrichment Organization will build and operate all plants which ultimately will be needed; European demand for enriched uranium is estimated to reach 15,000 tons in the 1980's.

The ultracentrifuge (or gas centrifuge) enrichment method, if economically feasible, would enable European nations to produce enriched uranium in factories which do not require the gigantic capital investment and power consumption of gas diffusion enrichment plants. The latter, at present the sole suppliers of enriched uranium to the free world's operators of nuclear power plants using that type of fuel, can produce economically only on a very large scale. Gas diffusion enrichment plants, furthermore, were not built to produce nuclear fuel economically for power stations; their primary mission was to produce weapons-grade highly enriched uranium for nuclear weapons plants.

Smaller Scale, Power, and Capital

In gas diffusion enrichment plants—in the U.S., in the United Kingdom, and in France—the fissile isotope U-235 is separated from the isotope U-238 by pumping uranium hexafluoride, a highly corrosive and toxic gas which is solid at room temperature, through thousands of successive membranes which let the lighter U-235 molecules pass more easily than the heavier U-238 molecules. As a result, the concentration of U-235 slowly increases. Natural uranium, and consequently uranium hexafluoride, contains less than 1 per cent of fissile U-235. Gas diffusion enrichment plants produce uranium hexafluoride in a wide variety of enrichment grades, from the 2-to-5 per cent grade, which then is turned into fuel for many types of nuclear power stations, to the over-90 per cent grade which is the raw material for nuclear weapons production.

In an ultracentrifuge (or gas centrifuge) plant, uranium hexafluoride will be pumped through long sequences of centrifuges spinning at speeds of between 50,000 and 100,000 r.p.m. The heavier U-238 molecules move towards the periphery of the spinning drums, whereas the lighter molecules of the fissile U-235 remain closer to the spin axis. Hex enriched in U-238 is recycled, whereas hex enriched in U-235 moves on to the next ultracentrifuge.

The advantages of the ultracentrifuge method over the gas diffusion method are its much smaller initial production scale and smaller power consumption—and therefore its low capital investment requirements. As Pearce Wright of *The* (London) *Times,* observed in *Spectrum*: "The capital costs of entering the diffusion field have deterred several countries from going into the enrichment business—particularly when added to the technical risks." A gas centrifuge plant can start production with relatively few cascades of centrifuges costing only a few hundred dollars each, and gradually expand its capacity.

Structural material and engineering demands are high, since acceleration forces of about one million times the force of gravity must be harnessed, and technical problems associated with high vacuum seals, rotor instabilities, etc., must be solved.

An Elaborate Industrial Complex

It was on March 11, 1969, when all technical hurdles appeared to have been solved, that the governments of the United Kingdom, the Netherlands, and the German Federal Republic reached a "broad agreement on the structure of a tripartite collaborative venture" in London. In the ensuing months, the details of the agreement were worked out in conferences at the level of government experts.

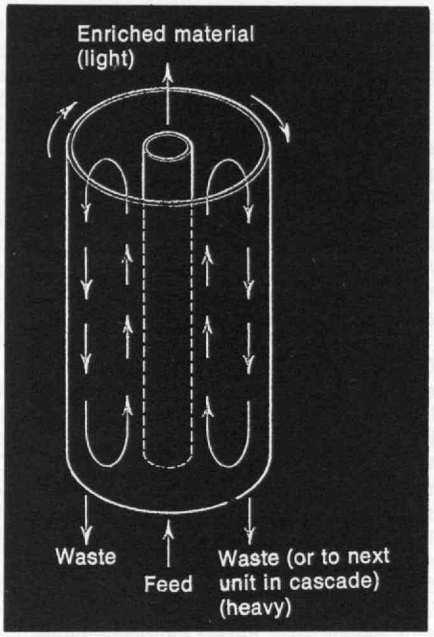
The Enrichment Organization will be run by three industrial groups: Ultra-Centrifuge Nederland N.V. (Netherlands), Uranit (Germany) and UKAEA (Britain). Ultra-Centrifuge Nederland N.V. (or UCN) is owned by the Netherlands government (56 per cent), Shell, Philips, and DSM (10 per cent each), VMF (7.5 per cent), and Rijn-Schelde (6.5 per cent). DSM is a government-owned chemical corporation. VMF and Rijn-Schelde are two groups of heavy machine and shipbuilding industries with a growing stake in the nuclear power plant equipment market. Uranit, or Uran-Isotopen-Trennungsgesellschaft, is owned by Farbwerke Hoechst (20 per cent), Gelsenkirchener Bergwerk (40 per cent), and Nukem (40 per cent). (Nukem is owned by Degussa—40 per cent, RWE—20 per cent, Metallgesellschaft—12 per cent, Rio Tinto—16 per cent, and others.) The British counterpart of these two industrial groupings, the British Nuclear Fuel Service, will be created by UKAEA.

The Enrichment Organization will ultimately own at least 51 per cent of the stock of each of the joint venture's two enrichment plants—one near Almelo, Netherlands, and one near Capenhurst, Britain. The rest of the stock will be owned by UCN (24.5 per cent) and Uranit (also 24.5 per cent) for the Almelo plant, and by UKAEA (49 per cent) for the Capenhurst plant.

Technological Cooperation on an "Essential" Product

In the initial stage, production in the Almelo plant will be split in two parts. One production line is scheduled to produce 25 tons of enriched uranium a year using techniques developed in the Netherlands, and the other, using German techniques, will also produce 25 tons a year. The Capenhurst plant, with the same initial production capacity, will apply British ultracentrifuge technology. It is assumed that these initial production capacities can be reached in 1972.

The elements of a gas ultracentrifuge: the outward movement of heavier molecules is augmented by heating the inner surface and thus introducing a convection current. (from Newnes' Concise Encyclopedia of Nuclear Energy, *1962)*



The purpose of this "three-pronged attack" is to find out which of the three is superior. A tripartite evaluation committee will then reapportion the three nations' shares in the joint venture. Within 18 months after the treaty has come into force the Prime Contractor Organization is required to produce blueprints of the ultimate joint enrichment facilities and ultracentrifuge factories. So far, each of the three nations involved has claimed that its centrifuges and its enrichment methods are superior.

The Prime Contractor Organization will be owned by UCN (Netherlands), Gesellschaft für Nucleare Verfahrenstechnik or GNV (Germany) and, most probably, UKAEA (Britain). GNV is owned by Interatom, Dornier, ERNO, and MAN. The Prime Contractor Organization will design, develop, and build enrichment facilities for the companies or industrial groups participating in the Enrichment Organization, and design and build factories mass-producing ultracentrifuges. Furthermore, the Prime Contractor Organization will have the exclusive right to sell manufacturing license rights or complete production units to other countries—provided buyers have ratified the Nonproliferation Treaty.

Beyond the initial production stage of twice 50 tons a year, the early production program will reach a capacity of 350 tons annually, of which 100 tons will be from the twin Almelo plants and 200 tons from the Capenhurst plant, with the remaining 50 tons not yet apportioned or appropriated. If demand on the continent in Europe rises beyond the 350-ton level quickly, it was tacitly agreed that capacity of the Almelo facilities may be raised first to at least 600 tons per year.

The price level aimed at, it was reliably learned, will be $26 per unit of separation work—the present U.S.A.E.C. price. The three governments, the December 19 announcement said, feel that the rapid rise in demand of enriched uranium for nuclear power stations makes the creation in Western Europe of a significant and growing capacity for uranium enrichment essentially important. The announcement also said the three governments feel that the ultracentrifuge way, under the present circumstances, will be economically the most attractive enrichment method.

Cooperation in this field of advanced technology may strengthen European technological cooperation in general and further, through joint industrial application, European economic integration.

J. A. Redeker is science editor of Algemeen Dagblad, *Rotterdam. Actively engaged in efforts to promote worldwide cooperation of science writers, he has taken part in several international conferences of science writers. His work has been published in* Aerospace Technology *and* Technology Week *(U.S.) and* New Scientist *(Britain). At present he is correspondent of* Science Journal *(Britain) in the Netherlands.*

ON COMPUTERS

SWITCHING AND FINITE AUTOMATA THEORY

Zvi Kohavi, Massachusetts Institute of Technology. *McGraw-Hill Computer Science Series.* 500 pages (tent.), $12.50 (tent.)

Helps to understand the structure, behavior, limitations, and computational capabilities of logical machines. It also provides specific techniques such as minimizing or decomposing combinational as well as sequential circuits, diagnosing logical circuits, designing fault-detection experiments, and techniques for designing special circuits.

SWITCHING THEORY

Paul E. Wood, Jr., Massachusetts Institute of Technology. *Lincoln Laboratory Publications.* 390 pages, $14.50

Developed and tested at M.I.T., this text for senior-graduate-level courses is designed to provide a comprehensive and up-to-date introduction to the field of switching theory. It contains all those topics which are central to switching theory, including certain important and interesting aspects of a supplementary nature.

INTRODUCTION TO APPLIED COMBINATORIAL MATHEMATICS

C. L. Liu, Massachusetts Institute of Technology. 448 pages, $13.50

Four aspects of combinatorial mathematics are covered: enumerative analysis, theory of graphs, optimization techniques, and design of experiments. The book is especially designed for advanced undergraduate and first-year graduate courses in computer science, engineering, and operations research. The text offers a wealth of examples that provide instruction and a wide variety of applications.

COMPUTER STRUCTURES: Examples and Readings

C. Gordon Bell and **Allen Newell,** both of Carnegie-Mellon University. *McGraw-Hill Computer Science Series.* 576 pages (tent.), $14.95 (tent.)

By utilizing a case study approach covering 40 distinct computer types, this work provides a taxonomical framework for analyzing the 1000 different computers extant. One-third of the book is original machine material, and of the 40 computers described, 10 are based on unpublished sources. It also covers computer design at the processors memory and program level, two levels which have recently emerged.

INTRODUCTION TO SWITCHING CIRCUIT THEORY

Donald D. Givone, State University of New York at Buffalo. *McGraw-Hill Computer Science Series.* 448 pages, (tent.), $13.50 (tent.)

Offers a middle ground between the one extreme of considering switching circuit theory as a set of logic design procedures and the other extreme of considering it as a pure mathematical study divorced from practical application. An entire chapter is devoted to the universal logic operations—the nand and nor operators.

ELECTRONIC COMPUTER TECHNOLOGY, Second Edition

Norman R. Scott, University of Michigan. *McGraw-Hill Series in Information Processing and Computers.* 640 pages (tent.), $18.95 (tent.)

Treats the entire field of computational systems as a continuum: from the analog through the digital computer with hybrid computer and interface means in between. It also integrates the engineer's logic circuit knowledge with computer design principles. Also included is a complete bibliography of resource material.

DIGITAL SIMULATION OF CONTINUOUS SYSTEMS

Yaohan Chu, University of Maryland. *McGraw-Hill Computer Science Series.* 423 pages, $14.50

Teaches the reader to use a digital computer in solving problems which previously could be solved only by an analog computer. The simulation languages are application-oriented, easy to learn, and simple to use.

INTRODUCTION TO DIGITAL COMPUTER PROBLEMS USING FORTRAN IV

Walter Dunn, University of Washington. 384 pages, $7.50

Teaches the student how to use Fortran IV. There are stated objectives and self-administered tests for each section, so that the reader knows what is expected of him.

McGRAW-HILL BOOK COMPANY, 330 West 42nd Street, New York, N.Y. 10036

Eliahn E. Traum, Nathan Sivin, Albert G. H. Dietz, John S. Lewis, Lynwood Bryant, Leopold R. Michel, Fred Wheeler

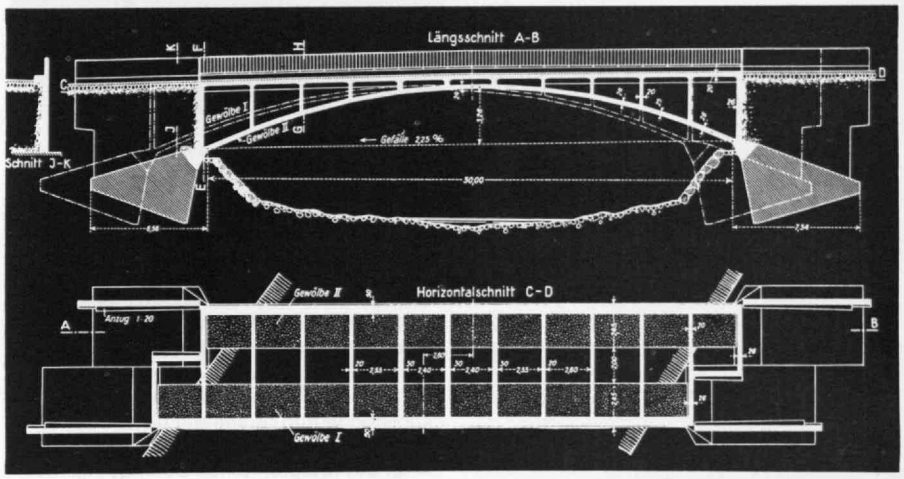
The Flow of Forces

Maillart: Engineer and Artist

Robert Maillart, Bridges and Constructions
Max Bill
New York, Frederick A. Praeger, 1969, 184 pp., $13.50

Reviewed by
Eliahu E. Traum
Visiting Professor of Structures, M.I.T.

Structural design is not just an analytical tool, it is a creative art, nourished and carried to greater heights by a deep understanding of the response of the structure as a whole to all the loads and internal forces acting on it. This is the message that Max Bill tries to convey to his readers by a well-presented collection of some of Robert Maillart's most significant works in the design of bridges and miscellaneous structures.



The first of Maillart's bridges to cross a river obliquely—the Hospital Bridge over the Engstligen between Frutigen and Adelboden. The bridge is of reinforced concrete, and consists of a staggered pair of arches.

The author assembled some of Maillart's papers (in English and in German), published in the 1930's in the "Schweizerische Bauzeitung," which could well be considered as the credo of Maillart the engineer and artist. These concise statements of his pioneering conceptualization of the structure as a whole, not just as an assembly of individual components, are a marked antithesis to the approach of most of Maillart's contemporaries in reinforced concrete. Maillart places all emphasis on an understanding of the flow of forces through the structure, shaping the form and dimensions to follow them; he fully utilizes the building material and eliminates any decorative frills. Designs based on this approach invariably result not only in most economical structures, but also in ones with an intrinsic artistic and esthetic appeal.

Max Bill illustrates Maillart's design philosophy by a careful selection of his completed and projected structures. The photos are of high quality, accompanied by illuminating information on section, dimensions, and construction details. The author is trying to make the point that, while Maillart deserves all credit for his technical ingenuity, his dexterity in the use of the building material and refined details, it is the artistic expression of his structures which has made the most striking impact. This emphasis, clearly revealing Bill's bias as an architect to esthetic criteria, seems to do a slight injustice to Maillart. While few would dispute the validity of Bill's short remarks accompanying each project and centering on esthetic aspects, it would have been far more useful to present Maillart's deliberations leading to the final design or a discussion of alternative solutions for the same parameters. The artistic effect of a design, clearly derived by one of the masters of the "form-follows-function" concept, would be the natural outgrowth of this approach.

While the author is fully aware of his preoccupation with the esthetic effects—which is understandable in a book neither intended for the scrutinizing technician nor the layman—he does also show Maillart as an outstanding engineer, far ahead of his time. Perhaps the illustrations showing the new applications of flat slabs on flaring column capitals, at a time when the methods of their analysis were not yet adequately known, serve best to prove how an intuitive understanding of structural behavior precedes and guides the analytical theoretician. What Maillart did half a century ago took decades to become commonplace. His design of a reinforced concrete shell for the Swiss National Exhibition in 1939, at a time when shell theory was still in its infancy, is another case in point.

Although much of the pioneering work of Maillart has become accepted practice and is even occasionally surpassed, this edition of his work is still very timely. Particularly nowadays, when many an engineer succumbs to the omnipotent computer and often tends to become merely its zealous manipulator, this book serves as a striking reminder that structural design is far more than an application of some mathematical formulas—it still is a real art.

Technological Missionaries

John Fryer: The Introduction of Western Science and Technology into Nineteenth Century China
Adrian A. Bennett
Cambridge, Harvard East Asian Research Center, 157 pp. $3.25

Reviewed by
Nathan Sivin, Associate Professor of the History of Science, M.I.T.

In 1861 John Fryer, having passed through the typical education of an ambitious middle-class Englishman of no

background and no prospects, went to China, like many others, to take up the most promising job available to him. After seven years of tedious and intellectually stultifying teaching, enlivened only by editorial work on a local newspaper published in Chinese, he went to work for the Chinese government as a translator in the newly founded Translation Bureau of the Kiangnan Arsenal in Shanghai.

The Arsenal was a pivotal element in the belated effort to generate the power the Empire needed to survive "enlightenment" by the West. The Translation Bureau and a language school represented within the Arsenal a slowly growing awareness that the naval and military superiority of the West depended upon a unitary and objective technology which had little in common with Chinese craft traditions. By evaluating the translations published by Fryer and his several colleagues, we can trace the gradual growth of understanding that at the living core of this technology lay an abstract mathematical science, and that the efficient exploitation of the whole for commercial profit and political power depended upon an institutional and legal system which could no longer be ignored. This was, at least, the growing understanding reflected in the changing priorities of John Fryer and his Chinese and European colleagues, who were free to choose what they would translate; but we know that the message reached a potentially influential minority who were willing to look to foreign models for change as the native models successively failed.

Fryer spent nearly 30 years at the Arsenal, before proceeding to Berkeley in 1896 to become the University of California's first professor of Asian studies. He had been involved in many other enterprises to spread popular scientific education within China—a science journal, a polytechnic institute and reading room, public lectures, a textbook series—none of them smashingly successful in altering the commonplace Chinese convictions about humanistic knowledge being all an educated and civilized man needed, and about the essential pointlessness of emulating foreign barbarians merely because of their efficiency at destruction. But by the end of his life Fryer had translated 129 books and pamphlets, almost all on technical subjects. He had provided textbooks for the first generation of Chinese engineers (particularly the self-taught; his books were never as widely used in schools as he had hoped).

Two hundred years earlier the translations of the Jesuits had accomplished very little, but now the need for them was apparent. There were much larger interstices in the social order into which talented men who tacitly rejected traditional humanistic values could fit, as these values seemed increasingly irrelevant to the problem of national survival. Fryer and his collaborators had systematically created Chinese technical terminologies which allowed them to communicate the state of the art in every branch of the study of number, nature, and power. Their success can easily be verified by the number of these terms which have survived into the Chinese literature of today.

The information which Bennett compiles can also tempt the reader into broader reflections. One is much less likely now than a hundred years ago to misapprehend that the task of Fryer and his collaborators was making science and technology available in China for the first time—although there is still no shortage of social scientists naive enough to think of modernization as the imposition of knowledge and technique upon intellectually passive recipients (to find out just what the recipients had been doing with their heads and hands all along requires, heaven forbid, the serious historical study of discredited ideas and techniques). But thanks to thousands of investigations, oriental and occidental, summed up in Joseph Needham's monumental survey *Science and Civilization in China,* we know that the problem was (as in every culture) one of interaction and competition with native traditions of considerable strength. Alexander Wylie, the most brilliant of the translators of Fryer's generation, spent much of his energy in the inverse process of introducing Chinese mathematics, astronomy, and other scientific traditions to the West, because he believed them worth the attention of any educated man. Li Shan-lan, who collaborated with Wylie in translating Euclid and with Fryer on Newton, had learned enough from traditional mathematics that, as a young man, when he came across an old Jesuit table of logarithms, he was able on his own to work out a method for computing them.

Whether, in fact, the Chinese tradition could have eventuated in a scientific revolution is a question often seriously asked, although to my mind we are far from ready to answer it with any sort of confidence that we know what we are talking about. But it is not hard to see why those caught up in the early stages of modernization thought of modern science and traditional science as mutually exclusive, competing for hegemony rather than capable to some extent of blending. It is hardly true that European science in 1870 had no need of anything that Asian thought had to offer. There was, for instance, the Chinese conception of the human body as an organism, affected as a whole by every alteration in psychological state and physical environment, its dynamic balance impaired throughout by the malfunction of any organ. We are just catching up to this view today.

What was at issue, in the end, was not the abstract merits and potential reconcilability of two systems of thought, but the contest between the social matrices in which they and their applications were embedded. The Chinese were first put on the path to modern physics not by the beauty of its laws or even their experimental verifiability, but by the navigational and destructive capabilities of steam-powered gunboats.

The whole story of the Chinese reception of modern science and technology has yet to be told, and it is not Adrian Bennett's aim to tell it. This book is rather a biographical sketch of an important figure, with much more attention paid to precise description of his activities than to evaluation of their long-term significance with respect to broad issues of social and cultural change. It was not undertaken as a definitive historical study of its subject, but is based chiefly on a survey of the papers, diaries, and translations which Fryer left to the University of California. Any reader will find it an informative initiation into the difficulties of propagating modern science before the days of UNESCO agencies. Anyone seeking to explore the process of modernization more deeply will come across many useful clues in Bennett's narrative, and no less in the lists of technical translations which he appends.

Polymers, Copolymers, and High Polymers

Chemical Plant Design With Reinforced Plastics
John H. Mallinson
New York, McGraw-Hill Book Co.,
443 pp., $29.50

Structural Design with Plastics
B. S. Benjamin
New York, Van Nostrand-Reinhold Co.,
259 pp.

Reviewed by
Albert G. H. Dietz
Professor of Building Engineering, M.I.T.

Plastics are called plastics because at some stage they are plastic; that is, they can be formed into desired shapes, sometimes by casting but usually by pressure and heat. They may be plastic only once, or they may become plastic any number of times. Plastics are organic materials—they are based on carbon chemistry; they are, in fact, high polymers —giant molecules made of numerous small, relatively simple repeating units combined into very large aggregations.

Because of the diversity of polymers, copolymers, and modifiers, the range of properties which can be achieved in

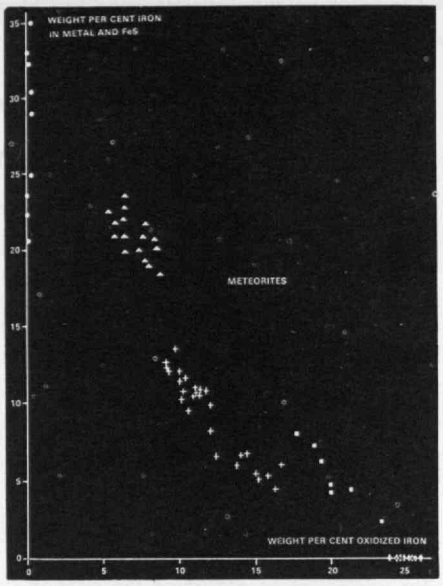
plastics is extensive. Among the most important for buildings are strength, stiffness, hardness, toughness, optical-visual characteristics, thermal response, permeability, resistance to fire, and durability. Some unidirectional laminates and reinforced plastics are among the strongest of all materials, especially on a strength-to-weight basis. Strength varies from these high values to low for some soft, flexible plastics. Similarly, stiffness may vary from the limpness of flexible films to moderately high; but even the stiffest reinforced plastics and laminates lie well below steel and aluminum and are more nearly in the range of concrete and wood.

Some plastics are extremely tough and resistant to breakage, others quite brittle. Like all structural materials, plastics expand and contract with rising and falling temperatures, but for many plastics these changes are appreciably larger than for other building materials.

There are still many unanswered questions respecting the durability of plastics under different exposure conditions. Resistance to corrosion is excellent. Resistance to rotting is also superior. The evidence is that plastics do not provide food for insects and vermin, but pests may attack plastics that get in their way. All plastics are resistant to a wide variety of solvents, but not necessarily to the same ones. Reinforced plastics frequently possess the combination of corrosion resistance and strength required to resist the chemical attack on materials encountered in chemical industries. For many applications, some combination of resin and fiber will be found suitable at a favorable cost.

Mallinson, with the support of a number of contributors, explores both the advantages and disadvantages of reinforced plastics in such uses. He begins with basic principles for the engineer unfamiliar with reinforced plastics by describing constituent materials, fabricating methods, and laminate systems. He devotes several chapters to piping systems based on polyesters, epoxies, and composites of these and other materials. Problems of joining and anchoring are taken up. A chapter is devoted to sewer and drainpiping, another to the important aspects of personnel, training, and safety. Additional chapters are devoted to ducts, storage tanks, electrical grounding, and to chemical-process equipment in general. Standards and costs are examined. Appendices are devoted to existing and proposed standards.

Although plastics represent a small percentage of the materials employed in construction, they are probably the fastest-growing segment. When reinforced with high-strength fibers, such as glass, they provide structural materials possessing the advantages of lightness, strength, toughness, ready formability, and light transmission when used in thin sections. They have the limitations of relatively low stiffness, relatively high cost per pound, short history of use with consequent uncertainty respecting aging and durability, and susceptibility to destruction by fire.



Analysis of meteorites in terms of proportions of oxidized iron and of metal and sulfide, reveals a number of distinct classes. From left to right across the graph: enstatite chondrites, bronzite chondrites, hypersthene chondrites, carbonaceous chondrites Type III, and carbonaceous chondrites Types I and II. (From the paper by Brian Mason in Extra-Terrestrial Matter.

Because of their newness, engineers and architects are unfamiliar with them and hesitate to use them. Benjamin's book provides a good introduction to plastics in general and the reinforced plastics as structural materials in particular. He defines these materials, introduces low density materials used as cores in sandwiches, goes into sandwich design, examines the shells and other shapes suitable for structural plastics, analyzes folded plates, and shows how stressed skin structures are particularly suitable for reinforced plastics. The book provides a good introduction for engineers and architects unfamiliar with this new class of structural materials.

More Things in Heaven

Extra-Terrestrial Matter
Charles A. Randall, Jr., Ed.
Northern Illinois University Press, 331 pp., $15.00

Reviewed by
John S. Lewis
Assistant Professor of Chemistry and Geochemistry, M.I.T.

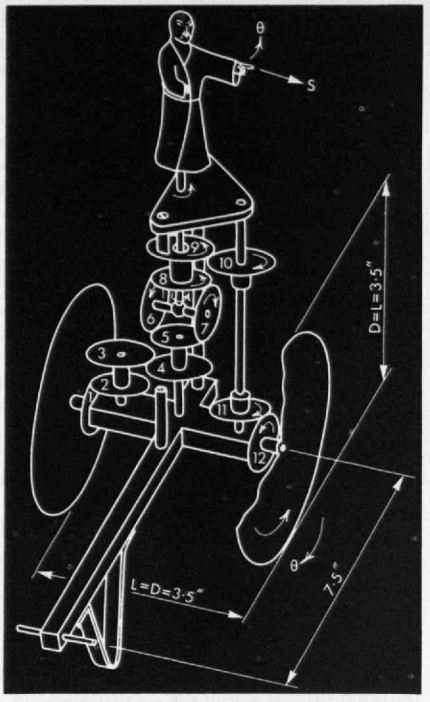
This volume is a collection of 14 review papers delivered at a conference at Argonne National Laboratory on March 7-8, 1968. The conference's purpose, stated by Randall as being "to review discoveries in geophysics, chemistry, and astrophysics at distances greater than one earth radius," is far from an accurate description of the resulting volume. The 14 papers published herein briefly summarize research in meteorites, tektites, the moon, cosmic rays (and their effects on Earth), comets, and interstellar dust. Four of the six papers on cosmic rays are concerned exclusively with effects of cosmic rays on Earth, and the "geophysics, chemistry, and astrophysics" would be better described as "radiation physics, meteoritics, and astronomy." Several types of "extraterrestrial matter," including stars, planets, asteroids, natural satellites, cosmic dust, and shower meteors, are unaccountably absent. It is a bit disappointing that the exciting space probe data on Venus and Mars available from Mariners II, IV, and V and the Soviet Venera IV probes were not mentioned.

The papers in this volume give somewhat limited (but worthwhile) accounts of the selected research areas listed above. These reports cannot of course be complete, and thus must reflect the value judgments of the individual authors. The text is largely a transcription of the taped conference proceedings, and no attempt has been made to alter the style of the material from a semiformal lecture format to more readable form. The book is completely unreferenced, which is most unfortunate for the reader who wishes to pursue some point which arouses his personal interest.

Yet despite these handicaps, the result is an interesting and useful volume, particularly to persons with a general scientific or technical background who desire to familiarize themselves with the general features of current space research. In this era in which the passage of one year may lead to the obsolescence of half the "knowledge" in a field, or increase the amount of available data by a factor of 10, it is uncommon for a conference volume to be useable two years after its germination. But even the papers on lunar science, that most volatile of disciplines, remain useful and interesting.

Several of the reviews in this book are worthy of special commendation. First, Brian Mason has given an interesting and fact-filled description of some current problems in meteorite research. Eugene Shoemaker and James H. Patterson contribute discussions on the chemistry and physics of the lunar surface which serve as useful background to the current results coming out of the Apollo lunar landings. The high point of the cosmic ray section is the review by Frank B. McDonald on the elemental composition of galactic and solar cosmic rays. The discussions of carbon-14 formation by Raymond Gold and of the electron content of primary cosmic rays by Peter Meyer are also of general interest. Ar-

The south-pointing chariot, used in China in ceremonial processions between 120 and 250 A.D ."It seems that its purpose must have been simply to cause awe and wonder in the onlookers, since whichever way the chariot was turned the figure on the top always pointed in the same direction." Wheels 3, 4, 9 and 10 are 1:1 spur gears, and the remainder 1:1 bevel gears.



mand Delsemme reviews our present understanding of comet nuclei in a manner which is indicative of one of the many ways in which "chemical" phenomena are being invoked to explain astronomical and planetological phenomena.

Perhaps the general utility of this volume would have been enhanced by decreased emphasis on cosmic radiation per se, and by increased coverage of subjects such as the effects of cosmic radiation and the solar wind on meteorites and planetary surfaces; the nature of asteroids, natural satellites, cosmic dust, and micrometeoroids; radiochemical dating techniques; cratering on the moon and planets; the solar nebula and the origin of the solar system; the physics and chemistry of the planets. Even with these omissions, however, this book will serve as a useful and fairly readable introduction or refresher to numerous readers. In the absence any better survey of space science on a comparable level, this volume may in fact prove welcome to quite a large public.

Learning by Doing

Simple Working Models of Historic Machines
Aubrey F. Burstall
Cambridge, M.I.T. Press, 1969, 79 pp., $3.95

Reviewed by
Lynwood Bryant
Professor of History, M.I.T.

For the past generation Professor Aubrey Burstall of the University of Newcastle has been using home-made working models of famous machines to illustrate the history of mechanical engineering for beginning students. This book describes 35 such models and shows how they might be constructed in an amateur's workshop.

The machines on Professor Burstall's list include classical toys like Hero's aeolipile, still the standard illustration of the principle of the reaction turbine, as well as many more practical mechanisms that were actually used for hoisting and pumping, two important tasks of mechanical engineering before the age of steam. All are old machines that take their energy mostly from men or animals or falling water. They include ingenious systems of levers and pulleys for moving heavy weights, and a variety of devices for raising water, including the suction pump so well known to our fathers, now a curiosity that requires explanation. Primitive machine tools are there, and a number of interesting devices for hammering and blowing. Most of the models are quite simple, but a dozen of them are complicated enough to offer a real challenge to some amateur craftsmen: the hydraulic ram, the escapement mechanism in a clock, or the ancient heat engine that was supposed to open and close temple doors automatically.

This is a how-to-do-it book, not a history. Its purpose is not to give authoritative descriptions of old machines, but to show an ordinary craftsman how to make a model with common tools and materials. Each project is illustrated with a full-page drawing, usually isometric, provided with a three-dimensional scale so that rough dimensions can be taken off with dividers. The instructions are very brief, sometimes only a few hints and warnings, and the drawing are not detailed, so that there is plenty of room left for the ingenuity of the home craftsman.

It is interesting that Burstall chooses to introduce students to mechanical engineering by trying to give them a sense for the historical development of their field, and also that he likes to do this by showing them working hardware. This kind of nonverbal experience, he believes, is a good way to give students a feel for mechanical principle as well as for historical development. It is a kind of historical laboratory experience that he has in mind, which puts students in touch with three-dimensional models through several senses. Much can be learned, he says, from feeling and touching a working model that eludes a student who only sees slides and films.

These are old-fashioned pedagogical principles, I can hear engineering educators say, more appropriate nowadays for elementary education than for engineering schools. We no longer have room in our curriculum, they say, for this kind of experience. I suppose they are right, but I imagine many teachers of engineering still feel some nostalgia for the old learning-by-doing principle, if not for the historical approach. I like both myself.

A Synergy of Management Scientists

Emerging Concepts in Management
Max S. Wortman, Jr., and Fred Luthans
Macmillan Co., 1969, 462 pp. £, $5.95

Reviewed by
Leopold R. Michel, Lecturer
School of Management, Boston College

With the idea of presenting a useful and orderly overview of significant changes which have occurred in management thinking in the last five years, Max Wortman of the University of Massachusetts and Fred Luthans of the University of Nevada have collaborated in a selection of pertinent articles roughly covering the period 1964-68. Keeping the emphasis on theories and concepts rather than specific methods and techniques, they divide the field into four broad philosophies of management: "process," behavioral, quantitative, and "systems." These, plus a general "foundations of management" category and some views on the future—as overture and finale, respectively—give the collection its six-part structure.

Within this structure, Wortman and Luthans present a range of interdisciplinary meeting-grounds, interrelating management with economics, psychology, social science, mathematics, and technology. They have selected the articles—46 of them, drawn from 27 publications—thoughtfully, not only as regards their relative importance within any one of the above-mentioned six divisions of current thought, but also as regards their orientation toward the future and their probable usefulness as foundations for further study.

Perhaps because conceptual aspects were favored over detailed application of techniques, the majority (35) of the authors are university faculty members, against seven holding positions in industry. The remaining four include two consultants, one staff member of the National Industrial Conference Board, and an editor of *Dun's Review*.

The book should not, however, be regarded as a mere "reader" in the chosen areas of management science, because Wortman and Luthans have written excellent summary previews for each of the six divisions, thus providing continuity and integration of the subject matter. By adding a list of discussion questions at the end of each major section, as well as additional selected references, they have arrived at a format which is ideally suitable as a basic or supplementary text in a business school curriculum.

While the 12-page index does not actually include the word "synergism," this scholarly compilation of carefully selected readings, edited and arranged into a single volume with a specific aim and purpose, itself shows a kind of synergy. Considering the vast number of publications now being produced in this field, Wortman's and Luthan's book should provide some most welcome assistance.

Awful Assembly

Effective Technical Speeches and Sessions
Howard H. Manko
New York, McGraw-Hill, 174 pp., $7.95

Reviewed by
Fred Wheeler

In medieval times, education began with the three-fold way, or trivium: logic, grammar, and rhetoric. This procedure insured that, if one ever learned anything else, one would be able to transmit whatever it was to others without their losing the thread, thinking one uncouth, or falling asleep.

With us, schooling is not done so well. The secrets we wrest so painfully from nature, and the all but impossible things we effect, are mumbled lifelessly into microphones to the accompaniment of inscrutable slides.

As technical sessions grow ever more tedious, their audiences tend to seek out pastimes more entertaining than listening to the papers, Mr. Manko observes. "It is evident that the locations for technical conventions are carefully chosen. The considerations given by the committees in charge apply only to the proper geographical locations, however . . . Participants are even encouraged to use the opportunity to bring their families to these resorts. In many cases, these meeting committees take it upon themselves to arrange further tours to adjoining areas of interest and at group rates, thereby making the proposition even more attractive. Unfortunately, only very little thought is given to the quality of the technical program itself . . . The attendance at the lecture hall," Mr. Manko observes, "is becoming progressively smaller."

Finding the merchants of light thus disporting themselves among the day-trippers, one might be forgiven for wondering whether the whole business of rational inquiry is at last going out of fashion. But for those who have not yet abandoned the great work, Mr. Manko has prepared an excellent treatise on rhetoric.

He tells you, in simple language, how to prepare a discourse—and indeed, how to decide whether you are worthy of this honor in the first place; he tells you the vitally important difference between a written paper and a public presentation (few noises can be more soporific than that of a man reading word for word the sterile document he has assembled for the Proceedings); he tells you, in sufficient technical detail, how the ingenious visual aids at your disposal can be used to show people what it is you are talking about: graphs like the Gordian knot, and vast illegible tabulations, belong in the preprint, if anywhere—not on the screen. He tells you how to avoid appearing unnecessarily oafish. By setting them out as checklists, he renders the usual mistakes rather easy to avoid.

Some of these checklists turn out to be surprisingly long, and should induce a salutory respect for the serious task of enlightening one's fellow seekers after truth, fame, and fortune. Of the three chapters addressed to organizers and chairmen, for example, one is devoted entirely to setting up the auditorium, and ends with a list of 26 items that have to be got right. Mr. Manko even tells you some of the smooth things you can say when completely irrelevant questions are asked from the floor. And there is a sort of appendix, running to 50 pages, on parliamentary procedure, by Registered Parliamentarian George W. Cavanaugh.

One thing you will not learn from this book: what to do when the radicals form up around the center-aisle microphone to denounce the entire panel as apologists for the military-industrial complex, and the rest of the audience divides itself into those who shout "Throw them out!" and those who shout "Right on!" Calling the meeting to order, says Cavanaugh, is usually done by rapping the gavel and saying "The meeting will be in order." If it won't, no book is going to help very much.

But, while the voice of dissent creates a little localized excitement now and then, the main trouble still is that too many meetings are rather less valuable and stimulating than their chairmen ritually claim. The Research and Development Director of Alpha Metals, Inc., and author of *Solders and Soldering*—for that is what Mr. Manko is—will deprive you of any excuse.

Town Plan for the Development of Selb
Town Planning: *Walter Gropius and The Architects Collaborative*
Traffic Planning: *Kurt Leibbrand and Verkehrs– und Industrieplanung GmbH*
The development of a master plan for Selb, a town of 20,000 in northeast Bavaria, was the last extended work of Walter Gropius, undertaken in collaboration with other members of his firm. This book presents that plan, together with the concurrently developed traffic control system. The principal designers and the town's mayor have contributed written accounts, but the greater part of the presentation takes the form of multicolored graphics, maps, photographs, and drawings. **$15.00**

The Bauhaus:
Weimar Dessau Berlin Chicago
by Hans M. Wingler
"This is an almost overwhelming documentary on the German school of design which was as much of an astounding creative happening as it was an institution whose influence on art education and our man-made environment still reverberates around the world. The 10"x14"x2" book includes among its 800 illustrations 24 color plates, as stunning as any to come off a press. . . . It adds up to a unique, one-stop source of research into one of the most important single catalysts of 20th-Century culture as well as 10 pounds worth of unmitigated pleasure for anyone who cares about modern art, design, and the design process."—*Wolf Von Eckardt* **$55.00**

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Experiment in Totality
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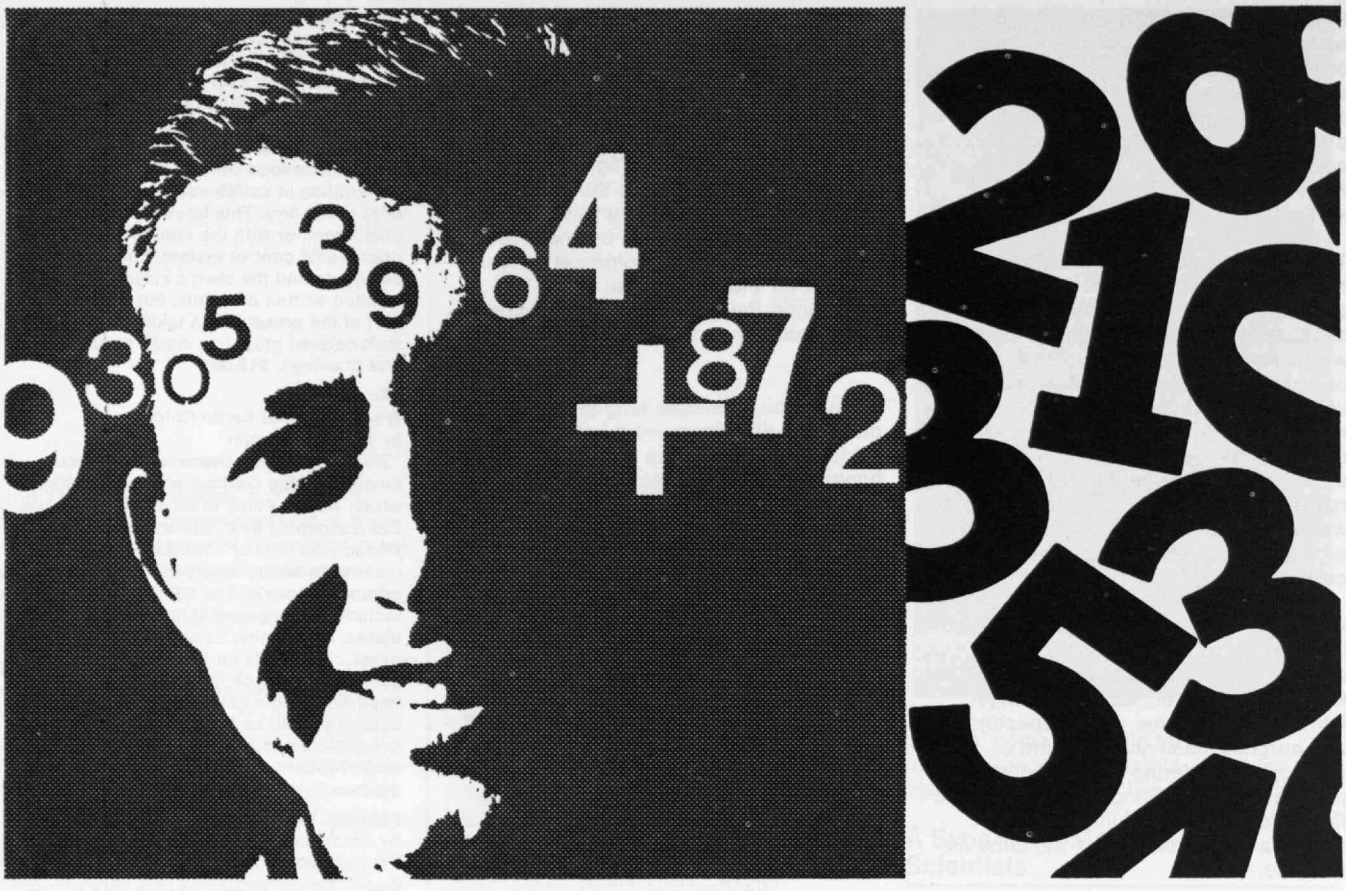

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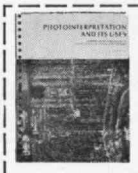

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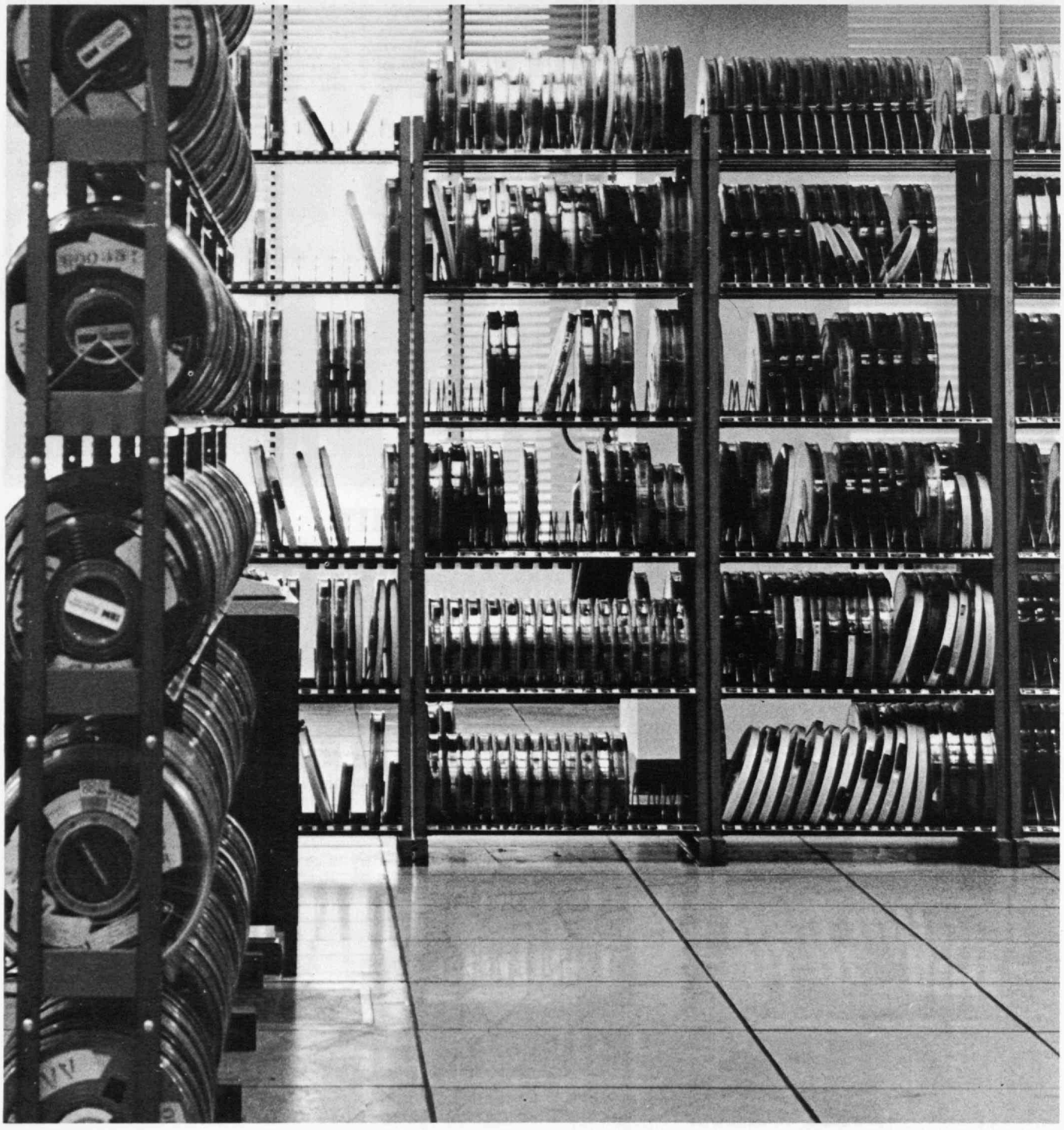
". . . a tendency for information and control to become even more centralized than they are already."



Computers can rescue us from the increasing burden of complexity in our society. But they can also create a dangerous imbalance of knowledge and power. The choice is ours—if we make it soon

Robert M. Fano
Ford Professor of Engineering, M.I.T.

Computers in Human Society—For Good or Ill?

We are already aware that computers have enormous effects on society. The implications are so broad and the future so uncertain that no one person—and no one article—should venture to predict the full impact of computers today or in the future.

Rather, I would try to draw two contrasting pictures of possible utilizations of computers in our society and discuss some of their implications and some of the factors that will influence the choice between them. One of them is the optimistic view of the future, the other the pessimistic view. I am an optimist, and I trust that the optimistic view will prevail; but of this I am by no means sure.

Let me begin with the optimistic view. The pattern of our business and private lives has been shaped by a great many products of technology which have greatly increased our mobility, our ability to communicate with one another, and our ability to reshape our physical environment to meet our needs. Of particular importance is the development of a great variety of power-driven tools, which help us daily in our business and private lives. These tools increase very effectively the power, precision, and skill of our muscles.

We can now foresee, by analogy, the development of intellectual aids which will increase in a similar manner the power, the precision, and the skill of our minds. The operation of these intellectual aids may be envisioned in the form of a dialogue between man and a computer system in which the latter acts as a knowledgable and skillful assistant to the man.

Brainwork Needs Communications

For this purpose, however, the computer system must possess certain specific characteristics. In the first place, the computer system should be easily accessible to people, both physically and intellectually. This means, for instance, that a person should be able to gain access to it at any time and from wherever he may be. It also means that the terminal device (teletypewriter, graphical display console, or whatever) through which he communicates with the computer system must be adapted to him as a human being—that is, it must fit, for instance, his motor and sensory capabilities.

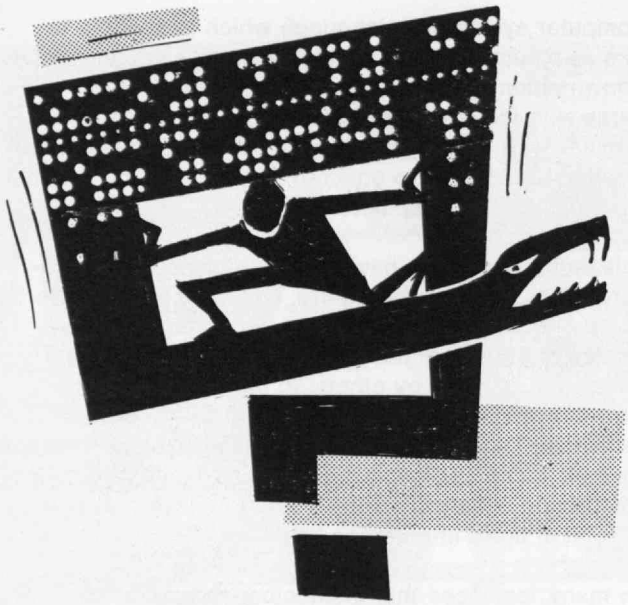
Intellectual access implies much more. It implies the ability on the part of the man to communicate with the computer system in a language which is suitable to him as a human being and to the specific subject of the conversation. That is, the man should be able to converse with the computer just as if it were an assistant familiar with the appropriate terminology. In particular, he should not have to concern himself with the internal operation of the computer.

Intellectual activities have an important common feature—their cooperative nature. One man builds upon the work of others, or he uses data generated by the activities of others, or his own activities generate data which will be used by others. In other words, interaction between people is fundamental to intellectual activities. Thus, if a computer system is to assist people in their intellectual activities, it must facilitate intellectual communication among them. I believe that this is a point of basic importance.

In many instances this intellectual communication must take place in real time, i.e., without appreciable delay. Consider, for example, a team of designers collaborating in some joint project. Each member of the team should be able to keep himself informed about the current state of the work of the other members of the team, so that he may take into account their design decisions or bring promptly to their attention design conflicts that may have arisen. Another example of real-time interaction is the collaboration between teachers and students. I shall return to this example later on.

In order to achieve real-time intellectual communication— *real-time* meaning without obstructive delays— it is of utmost importance that the computer system allow simultaneous access to itself by a large number of people. In addition, the system must be able to act as the repository of the knowledge of the community that it serves. In other words, it must act as a community library, containing not only the equivalent of books, reports, and journals but also the equivalent of the daily working papers of each member of the community.

This requires, of course, a very large memory capacity for storing huge amounts of programs and data. It also requires means for controlling access to each program or group of data—means for sharing such information with other people, but always under the strict control of its owner, so as to protect absolutely the privacy of his affairs.



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Computer systems possessing these features, at least in rudimentary form, are already in existence. One of them—the Compatible Time Sharing System—was used at the Joint M.I.T.-T.U.B. Summer Conference through a transatlantic link between Berlin, Germany, and Cambridge, Massachusetts. While much work remains to be done, engineers who have been engaged in the development of multiple-access computer systems are convinced that it is technically and economically possible to develop over the next decade networks of interconnected computer systems capable of offering a growing variety of services to the public—including new forms of home entertainment.

A Two-Way Mass Medium

The invention of the computer has been compared in importance with the invention of the printing press. I am inclined to believe that the impact of computers on the operation of society will be even more profound and pervasive than that of the press. The latter, and more recent products of our technology such as radio and television, have provided means for mass communication, but in one direction only. Books, newspapers, catalogs, and radio and television broadcasts are different forms of one-way mass communication—everybody reads or hears or sees the same thing.

Since printing and broadcasting are rather expensive, they must be aimed at a large public, and therefore all these forms of mass communication must be adapted to the interests of the "average man." But nobody is an average man, and therefore nobody is really satisfied. Furthermore, one-way mass communication tends to generate conformity and to discourage the differences in point of view and thought that form the basis of progress in our society.

We have the opportunity now to change this situation by developing computer-based systems that can provide two-way mass communication, systems in which each individual can select the information he wants and therefore go to a much greater depth into questions in which he is interested. There are physical limits to the size of any book, newspaper, or catalog, and there are time limits to broadcasts, which in turn limit the depth and variety of the information provided. Much more information can be stored in the mass memory of a computer.

Furthermore, only the raw, basic data need be stored, because any information that can be logically deduced from them can be assembled on demand by appropriate programs. I believe that the introduction of two-way mass communication will have a great impact on our society, and a beneficial one.

A Terminal for the Teacher

I would like to mention two other examples of ways in which computers may have considerable impact on our lives, which are particularly important to university education. One of my greatest frustrations as a teacher at M.I.T. has been inability to meet simultaneously the needs of all my students. Students in the same class differ greatly from one another in many respects, even in a highly selective university. They differ not only in their intellectual capabilities: some students like to proceed from the general to the specific, while others like to proceed from the specific to the general; some students refuse to pay attention to details before they have acquired an overall view of the subject, while others cannot see the forest before having examined in detail each tree; some students learn by going over material several times in increasing depth, while others prefer to examine one detail at a time.

It is indeed impossible to satisfy simultaneously the

needs of each individual student in a class of 20 or 25, still less in a class of 100 or 150. Individual instruction is, of course, the ideal answer to this problem. However, quite apart from economic limitations, the necessary number of qualified teachers is just not available. Computers, if properly used as intellectual aids to students in their learning process, may provide a way out of this difficulty.

Before moving precipitously to buy and install the necessary machines, we must consider very carefully what we are trying to achieve. For instance, computer-aided instruction is often misleadingly described as "replacing teachers with computers." This interpretation of computer-aided instruction implies mechanizing, rather than personalizing, education.

Instead, we should strive for an interaction between teacher and student through the *medium* of a computer system, in which the system facilitates their intellectual communication by acting as a knowledgeable and skillful assistant to both of them. In other words, the goal is to make it possible for a teacher to provide individual guidance to many students instead of few.

We may envision computer-aided instruction operating as follows: Each student uses the instruction material stored in the computer system, learning and answering test questions, under control of a program appropriate to his particular needs. The teacher monitors the progress of his students while they work, or at some later time, and modifies the control program for each student as needed. If a student encounters difficulties that cannot be resolved by the instruction program, the teacher is automatically called to give personal assistance through his own computer terminal.

Interaction between student and teacher through a computer is already a reality, although in a rudimentary form. My colleague Professor Joseph Weizenbaum, of the Electrical Engineering and Political Science Departments, has many times helped his M.I.T. students through a computer terminal in his home.

When considering computer-aided instruction, one must keep in mind the fact that knowledge cannot be divided into independent parts. Thus, just as a textbook on a particular subject makes references to textbooks on other subjects, an instruction program must be prepared

to call on other instruction programs during the course of a student session, depending on the individual needs of the student. Likewise, teachers in many disciplines may have to be called in for help. This will greatly affect the structure of the teaching programs and of the computer systems on which they operate.

More Specialties Than People?

Another frustration of teachers and students, and also of all practicing engineers and scientists, is our inability to keep abreast of expanding knowledge. Expanding knowledge and the limited capacity of the human mind are leading to a society of specialists who know more and more about less and less.

I am saying this only half facetiously, because the situation may be much more serious than it appears at first sight. As knowledge expands and the complexity of our society increases, more specialists in more different specialities are needed; we are thus heading toward a situation in which the effective operation of society will require more specialists than there are people. There are symptoms indicating that this saturation point may be closer than we think.

The basic problem is that we must find some way of

storing knowledge in a directly usable form—that is, in a form that permits people to apply it without having to master it in detail. Otherwise, every new generation will have to acquire the same knowledge and practice the same intellectual skills as the previous generations —and still find time to learn and then to build on what has lately been added to our store of knowledge. For instance, science and engineering students today spend a great deal of time learning calculus and practicing integration, because such mathematical skills—while not at the center of their field of interest—are nevertheless essential to their professional work. As a matter of fact, so much emphasis has to be placed on practicing integration that many students do not find time to master the concept of the integral.

Some recent work of my colleague Professor Joel Moses points the way to a possible solution to this very important and difficult problem. He has developed a computer program which can evaluate indefinite integrals (by ordinary symbolic—as contrasted with numerical—integration, which is the usual "brute-force" computer approach) and can solve classical differential equations as a competent mathematician would. The program follows the same procedures and uses the same techniques as a mathematician. It determines, by inspecting the form of the integral, what technique (such as integration by parts) is likely to be effective and tries it; and if the results are not satisfactory, it tries some other technique.

This program is an excellent example of how human knowledge can be stored in a computer program in a directly usable form, even when it is not possible to write a step-by-step, foolproof "algorithm" for the use (for there is no clear-cut procedure for evaluating indefinite integrals, even when the evaluation is at all possible). Integration is a difficult intellectual skill requiring a great deal of mathematical judgment as well as factual knowledge.

There is a crucial difference between storing knowledge in a book and storing it in a computer program. Knowledge stored in a book is useless until someone reads the book, learns its content, and practices the pertinent intellectual skills. When the same knowledge is stored in the form of a computer program, one has a choice. One can learn from the program as one would from a book, or one can have the program do the work as if it were a skillful assistant. Thus, computer programs may, in the future, meet society's need for more specialists in more different specialties and allow people to channel their intellectual energies in directions more rewarding and better matched to human capabilities.

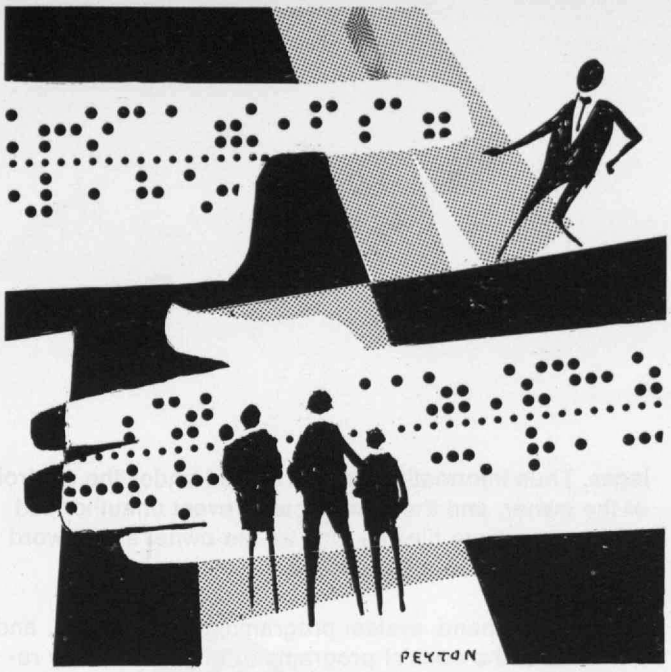
The adaptation of education to individual needs and the storage of human knowledge in directly usable form are only examples of areas in which computers may have very profound and beneficial effects on society. In general, the potential beneficial effects of which I am aware are in the direction of raising the level of operational complexity with which individuals and society as a whole may be able to cope successfully, and of expanding the range of choices open to each individual. In other words, I see a great opportunity to evolve a society offering a much greater opportunity for individual fulfillment through the lessening of operational as well as physical constraints in our daily lives.

This opportunity, however, hinges on bringing the power of computers to the service of the individual, which implies a significant departure from the attitudes and trends that prevail today.

The Pessimistic Picture

There are some serious dangers in the continuation of current attitudes and practices. For instance, the fact that most computer systems do *not* facilitate interaction between man and machine fosters a strong tendency to accept without adequate review, and act upon, conclusions generated by computers. Decisions which may be, in effect, delegated to computers range from those affecting individuals (the selection of employees, the granting of credit) to those in the economic, military and political arenas affecting whole nations and perhaps the entire world.

The danger does not lie in the possibility of computers making mistakes but in the possibility of human errors remaining undetected while the machine rolls on, compounding them: incorrect data, programming errors, and above all, the faulty or incomplete formulation of the problem that the computer has been asked to solve. Computers are "literal-minded": they solve the problem as it has been formulated and not as it ought to have been formulated. In particular, only those considerations which have been specifically stated are taken



into account in arriving at a solution.

In the hands of an alert human being, the formulation of a problem and its solution are usually concurrent—that is, the formulation of the problem is continuously modified as one gains a better understanding of the nature of the problem from the bits of "solution" that emerge wnile working on it. Without this continuous modification, faults in the formulation become apparent only when one arrives at a solution which, while logically correct, is nevertheless unacceptable for unexpected reasons.

My late colleague and mentor, Professor Norbert Weiner, used to illustrate with various tales of magic the dangers inherent in delegating decisions to computers. In the tale of "The Monkey's Paw," a man who wishes for £200 is visited by a representative of the company for which his son works, who informs him that his son has been killed in an accident and gives him £200 on behalf of the company. The next wish contains another logical oversight, and tragedy passes into horror. Computers, like magic, are literal-minded; it is our responsibility to make sure that what we ask for is indeed what we want.

Another consequence of the limitations of present-day computer systems with respect to man-machine interaction is a tendency for information and control to become even more centralized than they are already. Indeed, this would be difficult to avoid with present computer systems. Continuation of this trend would lead to human bureaucracies being replaced by much more rigid and unforgiving information and control systems.

The dangers to individual freedom are, however, much more serious than those implied by a computerized bureaucracy. Computers provide access to knowledge, and knowledge is power. Thus, unless computers are made truly accessible to the population at large, there will develop a dangerous power gap between those who have access to computers and those who have not, and particularly between organizations—whether public or private—and the private citizen. I do not see how individual freedom can survive in such circumstances. Computers may indeed become the pillars of the Orwellian world of *1984,* and Big Brother may well take the form of a computerized and centralized information system which has become essential to the operation of society.

Thus, the social exploitation of computers may proceed in two very different directions. The emphasis may be toward turning the power of computers to the service of the individual, so as to augment his intellectual capabilities and enable him to cope with a much higher level of operational complexity in society. Or the emphasis may continue on the automation of existing functions in human organizations, with a concomitant centralization of information and control. The first direction leads to strengthening human organizations by augmenting the capabilities of the individuals in them, while the second direction leads to the evolution of organizations into superhuman entities with their own goals, largely insensitive to human values.

Different computer technologies are best suited to these different objectives, and therefore the evolution of computer technology will itself be stimulated in different directions depending on the road that society will follow. In attempting to solve its operational problems, society must of necessity use whatever means technology is able to offer at the time, readjusting its modes of operation to the tools that are available.

Once a particular mode of operation has been adopted, the development of better tools *of the same type* is powerfully stimulated. It is this feedback between mode of operation and evolution of technology which may generate irreversible changes in our society.

Individual Privacy

Putting the power of computers to the service of the individual requires the solution of many difficult problems, technical and social. The protection of individual privacy in a computerized society is a good illustration. It seems clear that the ability of a computer system to assist people in their activities depends on its possessing a great deal of information about the people who desire its assistance, as well as about other matters. As a mat-

ter of fact, part of the assistance that a computer system may provide to an individual is simply the automatic recording for future reference of factual information about his activities; it might collect this information in the very process of assisting him in his daily activities, as a good secretary would (*secretary* and *secret* have the same origin, for this reason). The net result would be that the life of an individual would be described in great detail in the mass memory of the computer system. For other people to gain access to such detailed personal information would be intolerable.

Professor Alan F. Westin of Columbia University defines privacy as "the claim of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others. . . . The individual's desire for privacy is never absolute, since participation in society is an equally powerful desire." Further, he considers that "the modern claim to privacy derives first from man's animal origins and is shared, in quite real terms, by men and women living in primitive societies."

The crucial point is that a man may wish to share or withhold the same information, depending on circumstances. Thus, each individual should have control over any information about himself stored in a computer system, and the computer system should be able to protect such information against illegal disclosure or modification. (And the illegal insertion of derogatory information could have much more serious consequences than an infringement of privacy.)

The Compatible Time Sharing System, which has been in operation at M.I.T. for several years and to which I have alluded earlier, permits the controlled sharing of information, but it is far from adequate in its protection of privacy.

Every user of the system has his own password which certifies his identity to the system and which can be changed by the user whenever he so desires; the correct password must be given in order to gain access to any user's private files. However, a user may give specific permission to other users to access specific information in his own private files without having to disclose his password to them. This permission can be given to specific users, or to everybody, and it can be qualified for reading only or for full reading and writing privileges. Thus information can be shared under the control of the owner, and the system can prevent unauthorized access to private files as long as the owner's password is not disclosed to other people.

On the other hand, system programmers are fallible, and mistakes in the control programs of the system may remain undetected for a long time. As a matter of fact, they may be discovered by users inclined to exploit them to their own advantage or for other malicious purposes. Our experience at M.I.T. indicates that these dangers are very real and that no community can be assumed to be immune from them.

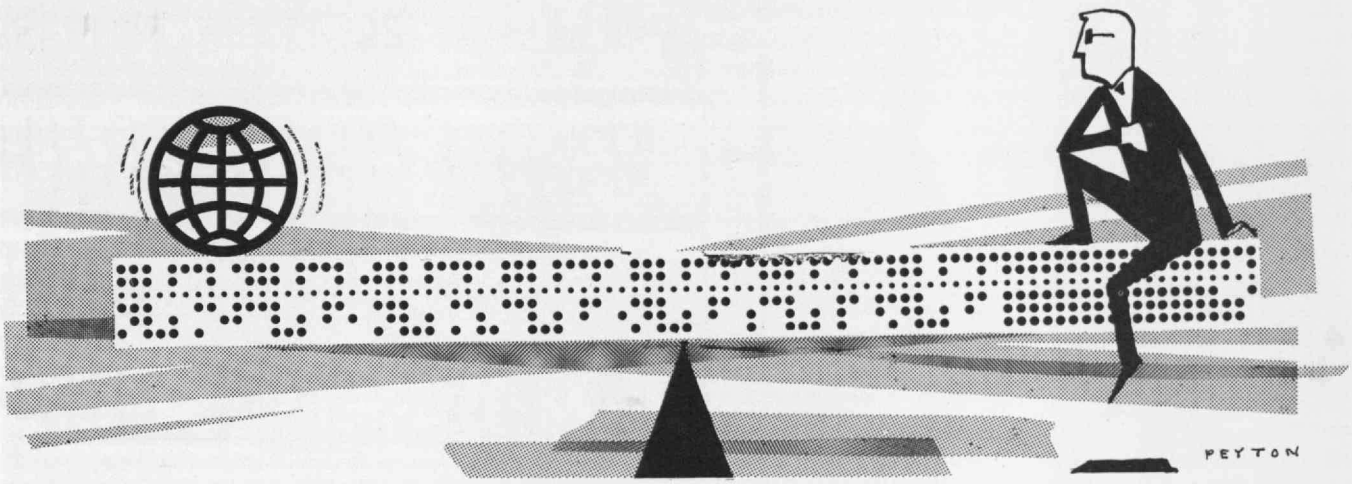
There is no simple answer to the problem of protecting a computer system against intruders. The system must possess several lines of defense. It must include programs that periodically check its operation, and it must provide facilities for detecting illegal activities and for collecting whatever information may be required to apprehend the perpetrators.

The legal and political aspects of the problem are at least as complex. The right to privacy must be defined and protected by suitable legislation, and appropriate regulations must be enacted to protect the users of public computer systems, just as the safety of a bridge or a building is certified. Perhaps the public body charged with this responsibility should audit periodically the operation of such systems to insure that they do in fact remain safe and that the system managers do not take advantage of their privileged positions. These problems are not only difficult from a legal standpoint but also fraught with political issues.

An Irrevocable Choice

Let me now summarize the main points of my argument. The complexity of the operations upon which our society relies has grown beyond the level with which the unaided human mind can cope successfully. Our society may well fall apart under the weight of its own complexity, just as animals which were too large and clumsy have disappeared from our planet. Computers can provide the help we need and a much better opportunity for individual fulfillment. They can also create a dangerous imbalance of knowledge and power in society and an "information prison" for each of us.

Much will depend on our willingness to give proper



priority to human values, mindful of the fact that human organizations and institutions exist to facilitate the satisfaction of individual needs and goals, both spiritual and material. There is a great temptation to base our decisions on cost-effectiveness computations that do not take into account individual values or social costs. No—the time has come to adapt computers to the idiosyncrasies of people, instead of asking people to adapt themselves to the idiosyncrasies of computers.

Good intentions are not sufficient. We must gain a much better understanding of how computers interact with society and then act accordingly. The exploitation of computers in the operation of society is proceeding at a very fast rate; we cannot afford to wait for problems to become critical before tackling them. As I said earlier, computers may be used to assist the individual in his daily activities, thereby enhancing the capabilities of society as a whole, or they may be used to automate the functions of human organizations, placing them beyond the understanding and control of the people affected. Computer technology is not yet irreversibly biased toward either mode of exploitation, but it will not remain unbiased for much longer.

The technical community has a particularly heavy responsibility in these matters. The future will be largely determined by the technical objectives to which resources will be devoted, and the specific characteristics of the computer systems and of the computer-based services that will be made available. The pressures on society arising from the multitude of interactions within it and from its operational complexity can be relieved only through the use of computers, and society will have little choice but to use the computer aids that will be available at any given time and to adapt its operation to them. Unless we are mindful of the long-term effects of our decisions, we may become prisoners of a social system we did not consciously select.

Suggested Readings

"Computers in the Service of Society" (articles by J. W. Forrester, A. F. Westin, N. P. Negroponte, and E. E. David, Jr.), *Technology Review,* Vol. 71, No. 6, April, 1969.

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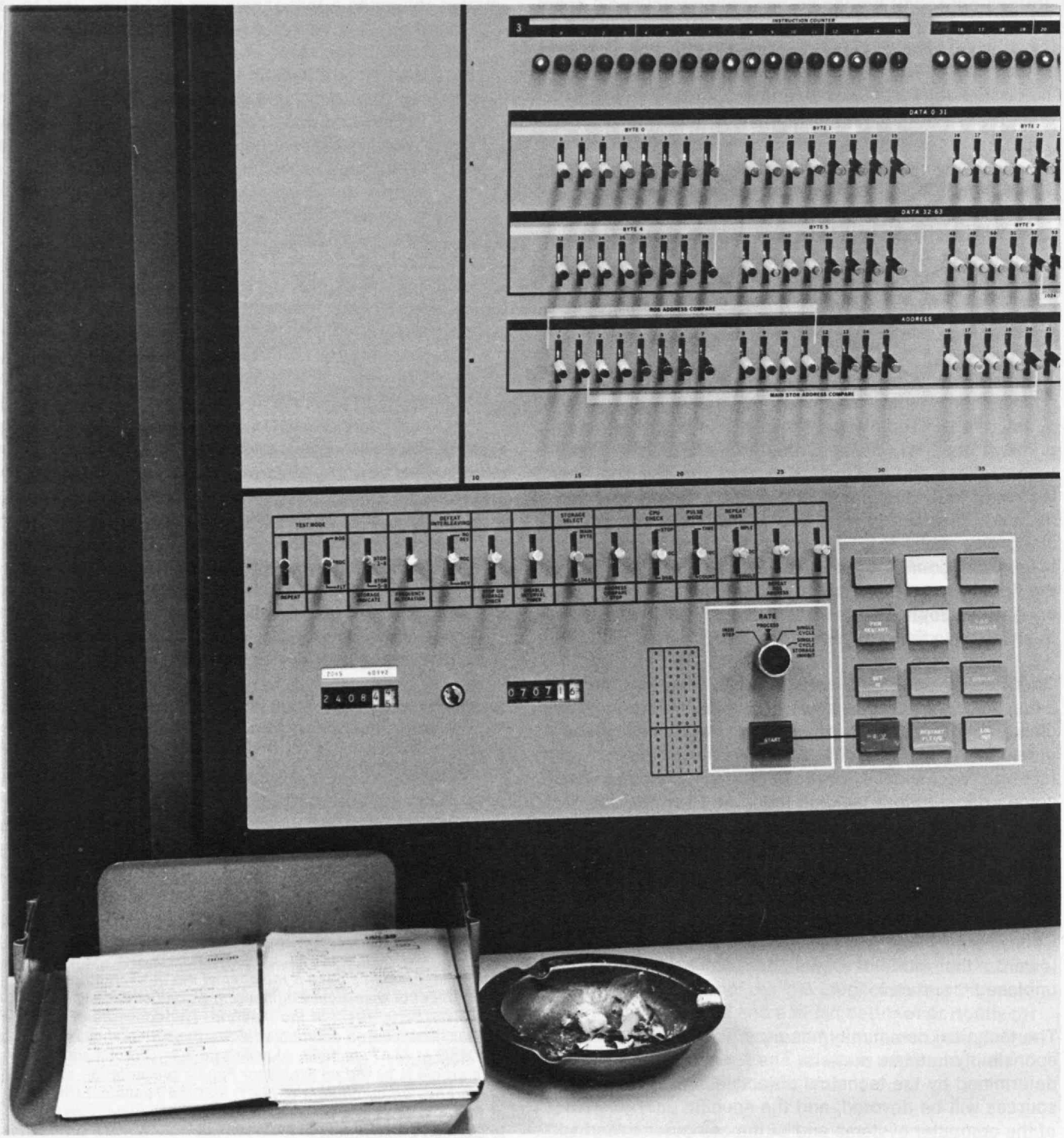
Robert M. Fano has been a member of the M.I.T. faculty in the Department of Electrical Engineering since completing graduate work (Sc.D. 1947) at the Institute. The concepts of multiple-access, time-shared computers led to the establishment of Project MAC at M.I.T. in 1963, of which he was Director until 1968. This article is based on Professor Fano's presentation at a joint conference on computers of M.I.T. and the Technical University of Berlin in 1968 in Berlin, and it has recently been published in German Engineering.

"It should be possible for the computer to decide, when someone makes a request for access, whether to grant it to him"



The protection of private or proprietary information contained in computer systems is technically possible; it is essential that the problems still remaining be tackled and the methods made public

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Making Computerized Knowledge Safe for People

The primeval creation of language, the ancient invention of writing, the renaissance innovation of printing and the modern refinement of electronics: all bear witness to the basic human drive to share information. But always certain information has been regarded as private or proprietary, and its possessors have insisted on their right to control the conditions and the extent of its sharing.

We regard it as a violation of a person's liberty if he is forced to divulge information against his will. Further, people have devised ways of sharing information while retaining some rights in regard to its further use. A person speaks freely to a doctor, relying on the traditional confidentiality of their relationship. A man publishes a book, assured that it cannot be legally republished or reproduced without his permission. Some of these procedures are quite informal: a participant in a scientific meeting will often ask whether a tape is being made or whether journalists are present and adjust his remarks accordingly.

The computer is a new means of information sharing, vastly more powerful than the spoken word or writing. Moreover, it handles information in a new form. The copyright, introduced to control printing, is as inadequate to govern its capabilities as the medieval scribe's code of ethics was to deal with the possibilities introduced by the printing press. New means of information sharing demand new means of control.

Two capabilities of the computer are responsible for its great power. First, the volume of information which can be stored in a computer, and the speed of storage and retrieval, are so much greater than for written records that the difference in magnitude becomes a qualitative difference. Already people are using computers to keep such quantities of records that there would not have been clerks enough in the country to cope with them. Banks and stock exchanges are racing to computerize their operations. When people come to rely on the data-processing abilities of computers, the data must be protected from tampering or misuse. Otherwise, as the old joke goes, the computer can "make a mistake" in a few minutes that would have taken ten clerks a hundred years.

Second, the computer stores not only data but also programs which are directly usable. A book can tell how to do something; a program actually does it. If computer-stored knowledge is stolen, the processes of law move too slowly to redress the grievance. This fact, combined with the speed and magnitude of pilferage possible, as well as the intangible quality of what is pilfered, means that such piracy would strain our notion of copyright and swamp present methods of law enforcement. It is as though the Xerox machine could be used to reproduce not merely engineering drawings but the engineering itself.

These two capacities of the computer, positively viewed, have led computer specialists to envision a phenomenon termed "the fireside computer" or "the computer utility." Not too long hence, in this vision, every home will have a teletypewriter terminal for communicating with a central computer, just as homes now have telephones. The terminal will be attached by telephone lines to a central computer, where the family keeps special-purpose programs (e.g. for answering the phone and taking messages when nobody is home), and where the family keeps all important records—the bank account, the deed to house and property, the family medical record, a list of books currently out of the library, and a "mail box." The bank account is shared with the bank, and the family can pay all bills by dialing up the computer and transferring "funds" directly into other computer-stored accounts. The family receives mail whenever someone types a letter at his terminal and transfers it into the family's computer mail box. Hand delivery of writing on paper is no longer necessary.

Much of this information is confidential or strictly private. Should the man's medical record be open to a prospective employer? Should his bank account be available for perusal by the F.B.I. or by credit bureaus? Simply making such snooping illegal is not sufficient, for it may be difficult to detect. Further, the result of successful snooping is power over the victim: knowledge is power. The man is not hired or he is refused credit, and he doesn't even know why. Perhaps the F.B.I. suggests that he stop doing business with a certain "suspicious character." Will he himself become a "suspicious character" if he refuses, and will his mail box be searched for the names of friends and colleagues to be warned?

This is neither science fiction nor inevitable fact. It is a picture of what *might* happen if we try to control the

power of tomorrow with the techniques of yesterday. The computer's speed of processing, volume of storage, and ability not only to store but to act outstrip the legal concepts and law enforcement techniques that were adequate for oral and written information.

But computers also possess, potentially, the ability to protect the information stored in them. Indeed, they can provide the means whereby the author of computer-based information can exert the control that he would like to have over access to and use of that information. Whether the user of the system will have that control depends on how the "access control" mechanisms of a computer system are designed.

The Confidential Machine

To be effective, the access control routine of a computer system must satisfy five basic requirements.

First, enforcement must be built in. Locking the barn door in time is always preferable to chasing after the escaped horse.

Second, the method of access control must not involve any great loss in efficiency or economy, or it will never be used—managers of a computer utility will somehow bypass the means of access control to save time and money, as if it were some cumbersome piece of bureaucracy.

Third, the cost of illegally accessing information stored in a computer must be so much greater than the benefit expected from the violation that no one could perform an illegal access by mistake and no one would want to do it deliberately.

Fourth, the computer user must be able to specify exactly what he wants to permit in the way of access by particular people to particular information. He knows the extent to which he is willing to share the information, and his will should not be forced into the Procrustean bed of "what the computer can do."

Fifth, the facilities available to the user of a computer system must be simple to use. If a person finds it as complicated to control the sharing of a piece of information as it is to compute his income tax, he will give up. Instead of protecting his rights he will grant others enough access so that he can continue to function in society, and then pray that he hasn't given away too much.

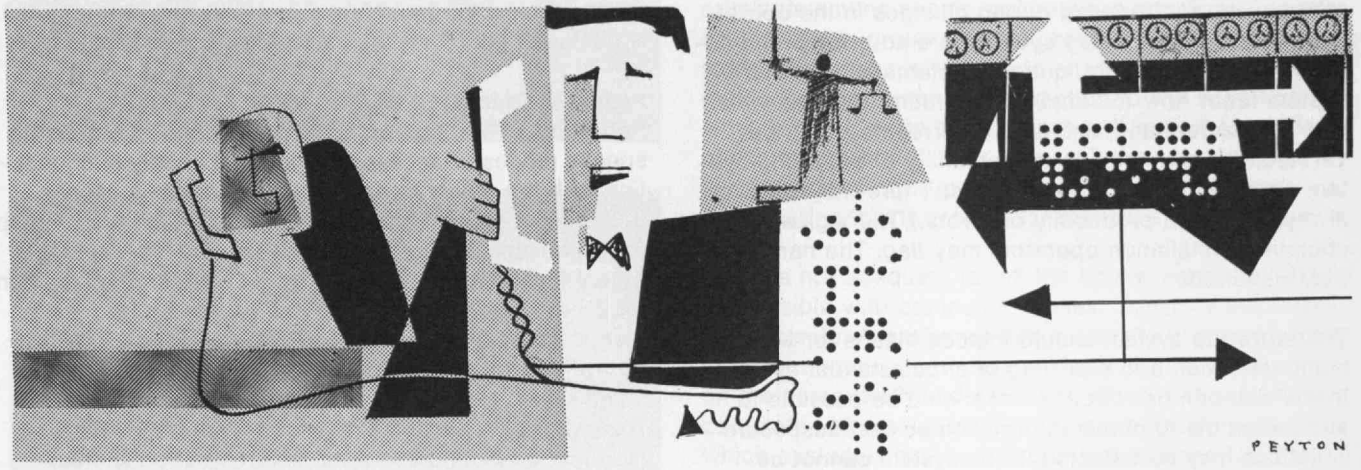
The common theme of these specifications is "let the computer do it." The great power of the computer can be controlled only by the computer itself (an analogy is the powered control actuators of a jet aircraft). The job of the computer system designer is to create a coordinated set of mechanisms to meet these specifications. The remainder of this article will be devoted to discussing what this means in practice.

Built-in Enforcement

The key to use of the computer for access control is enforcement. The computer can be used for checking the permissibility of an intended access *before it is made.* This is possible whenever a person's use of the computer is under the control of an operating system (which is itself a set of programmed procedures). The only way a person has of obtaining information is to request the operating system to provide him with it. The operating system, on receiving the request, checks to find out whether the requested access has been permitted by the information's owner. If not, the request is denied. The requestor cannot *disobey* the operating system—he simply can't get to the information.

Any technique for access control is based on the same principle: a person is able (not "allowed" but "able") to reach information only through a mediator. The mediator may be in the hardware of the machine or in the software of the operating system.

The same technique can be used to enforce other conditions for access. Suppose a person has expended great effort to create a computer program which can be of general use. He is willing to share the program but desires financial compensation for his work. He can lease out the program to another person, but how can he arrange to be paid each time the program is run, so that payment is proportional to use? Let the computer do it! The solution is to interpose a mediator between the hirer and the rented program. Each time a hirer requests use of the program the mediator transfers funds from his (computer-based) account to that of the owner. This technique is more effective and less bothersome than making arrangements, without the aid of a computer, to patent, lease, receive payments for, and guard a patented program.



Efficiency

The use of mediators to enforce access restrictions is subject to constraints of efficiency and economy. The computer's speed is great enough to make a mediator feasible, but it is not infinite; too many appeals to a sluggish or excessively complicated mediator program could cause the computer to spend all its time mediating and no time doing the intended work (human parallels will immediately spring to mind).

A completely general facility would refer every request by any program to a mediator, itself a program, which could become inordinately complex. In practice, most access control has to be done by hardware, so that it can be done quickly, and most of the rest by carefully designed, efficient operating-system programs provided by the designers of the total system.

For this reason, the facilities available to computer users are determined by the designers of both the hardware and the operating system. They have the responsibility of ensuring that the control is adequate.

Maximum Protection

If the access control of a computer system is to prevent any unwanted access, it must guarantee that only specifically permitted references will be allowed. Responsibility for preventing unwanted access is shared between the physical containers of bits of information, the operating system that mediates access to them, and the owner who specifies exactly what the access will be.

The computer system—machine and operating system together—cannot guarantee that the owner will correctly specify access (although, as we shall see, a bad system can *prevent* him from doing so). But it can make access without his permission impossible. Thus, it should be impossible to get to information except through the operating system—which must be foolproof—and, physically, storage of the bits should be either inaccessible to the curious or uninterpretable by them (or by their computer).

In an age of wire-tapping and code-breaking the latter is a difficult goal, still beyond the reach of telephone and computer engineers. The implication for the operation of a computer installation is that tapes, disks, and other physical storage media must be managed according to the privacy of their contents. For the machine design, the implication is that the internal instructions which elicit information from the memory can be executed only with the aid of the operating system, so that the latter cannot be bypassed.

The operating system must be able to determine the identity of any prospective user and to check his request to use information against its owner's specification of permissible users. If there are loopholes in the method of identification or in the method of denying access, then sooner or later violations will occur.

Probably violations will occur anyway. In conformity with Murphy's law, it seems reasonable to assume that some loopholes will go undetected in testing and that

others will be introduced during changes in the operating system. (Present-day systems are so error-prone because they are, in fact, quite unsystematic. When designers learn how to construct operating systems which they can understand, and whose correctness can be verified, the extremely high probability of operating-system errors will be sharply reduced. There will, however, always be some probability of errors.) The vigilance of computer installation operators may flag. The hardware may malfunction.

Therefore the system should include means for automatic detection and reporting of circumstantial evidence that a violation has occurred. It should be possible to audit attempts to obtain information so that suspected violations may be detected. If the system cannot be infallible, it can at least include a second-line defensive array of protection mechanisms.

These, then, are the ways in which the hardware and the operating system cooperate to maximize protection of computer-stored information.

What the User Needs

The third locus of responsibility for access control is the user, who must specify who exactly will have access to his information, for what purpose, and so on; and he must be exact in this, for the system will guarantee that no other access will occur. The operating system must therefore provide him with facilities for describing his desires and needs concerning access.

This requirement is a challenge to computer system designers, because it must be balanced against the need for efficiency. Operating system designers have devoted a good deal of attention to creating facilities which are efficient, foolproof, and yet general enough to permit as much sharing as the users may desire. If only the first two desiderata are emphasized, the user is apt to find that he is frustratingly restricted in the kind of sharing he is allowed to do.

One thing that a person wants to be able to specify about information is what may be done to it. The information contained in a book may be read, or it may be copied. Hence the copyright laws, allowing the former while restricting the latter. The information may also be supplemented with underlinings and remarks in the margin, but that is of no concern to the author.

Computer-stored information is subject to three modes of access: read, write, and execute. It may be (a) read, (b) altered—which means that the original is overwritten—or (c), in the case of a program, executed—that is, the program is actually run and does something. A person who leases the use of his program to another wants the other person to execute the program but not to copy it (using the "read" mode of access), let alone change it (by rewriting it). A person may be granted none of these access modes (in which case any attempt to refer to the information in question is rejected by the operating system), or any one, or all of them (for example, a person may treat his *own* program any way he wishes).

An operating system should also allow the user to interpose a special-purpose mediator—perhaps a program for examining the applicant's credentials in some detail—between his information and an attempted reference.

Progress in Information Sharing

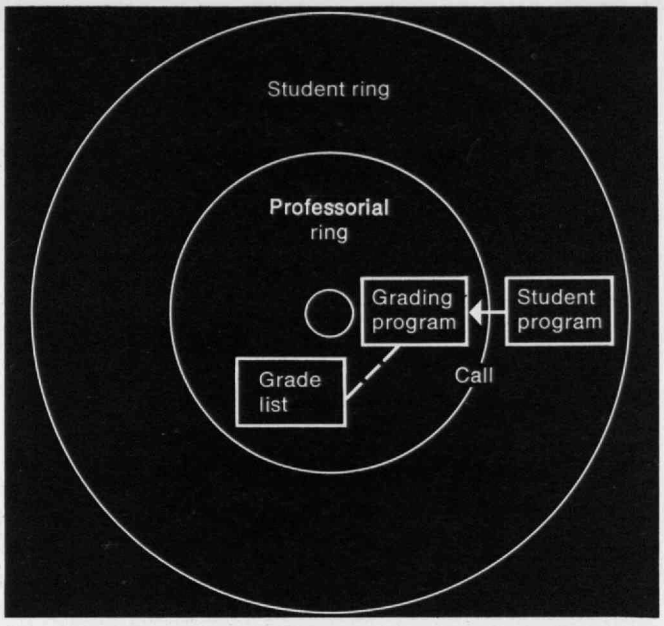
Returning to first principles for a moment: the ability to specify modes of access is of interest chiefly in connection with the ability to specify who shall have access (although it is also useful as a protective device to keep the owner himself from overwriting his own irreplaceable information). A system without any sharing between its users is safe and efficient, but it denies the drive in men to communicate and to share knowledge. The history of controlled sharing in computer systems has to some extent been one of successive relaxations of the restrictions on sharing. Each step has been marked by the discovery of how to remove a restriction without making the system unsafe or inefficient.

The first step was to make a distinction between information which is not to be shared and information which can be shared. If a person was willing to share a file of information with other people in general, he placed it in the computer's "public library." This facility enabled people to share programs and data but did nothing about communication between individual users—there was no "mail box." Nor did such a system allow the user to specify that, for example, one person might write into a public record but another person might only read what was written.

The next step was the group library. This device allowed for information to be public within a specific group of users but not accessible at all outside the group. This system was both too restrictive—it prohibited sharing between groups—and too indiscriminate—it gave no privacy *within* the group.

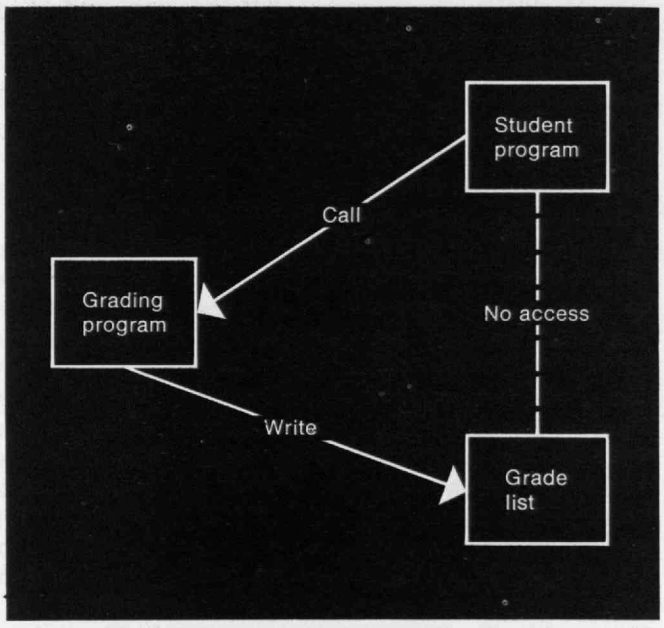
Another experiment was with the use of passwords. This is an example of an attempt to relax restrictions resulting in insufficient protection. A file of information was available only to those who could type a password, the secrecy of which had to be safeguarded by the author of the file. Obviously, anyone who learned the password was able to pass it on, thus granting access to the information. The source of the difficulty was that people were trying to manage access themselves, without the aid of the computer.

When they share information, people ultimately dis-



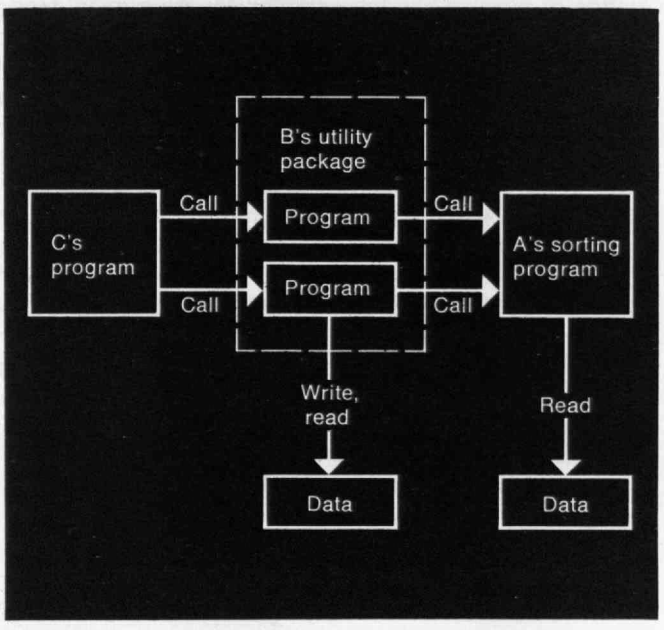
If access to computer-held material is restricted to specified individuals, this can be too great a limitation for some purposes. Greater freedom is possible if the material is arranged hierarchically, as in the first diagram, where the "professorial" grade list can be altered by a "professorial" program, but not by a program in the "student" level which is able to "call" the professorial program for grading. An improvement for business uses is the idea of specifying access paths. The second diagram shows this approach to the student-grading problem; the third illustrates its application where software is hired out along a chain of users while each retains control over the use of his own data.

criminate among people, not between private and public or between in-group and out-group. So the obvious next step in relaxing restrictions to sharing was to provide a facility for the owner of information to say specifically what persons might have access to it and what access each person should have. This technique is currently in use and provides most people with all the control over sharing that they need for present applications.



But it is not adequate for all the applications that should be possible with computer utilities. Consider the following example. A professor has a grading program which looks at a student's homework (why not do homework on the computer?) and grades it. When a student has completed his assignment he runs the grading program, which evaluates his work and enters a grade for the student into the professor's grade list (also stored on the computer). Now, if students are permitted to write on the grade list, some enterprizing student will give himself an A and not bother with the homework assignment. But if students are not permitted to write on the grade list, then when a student tries to run the grading program he will be unable to write his grade.

The problem is that although discrimination between persons is sufficient for controlling many types of sharing, a finer distinction must sometimes be drawn. The question is not always, Who is attempting access? but sometimes, What program, acting on whose behalf, is attempting access?



The next step, then, in relaxing restrictions placed on sharing was to provide the owner of information with a way of discriminating between two programs being run by the same user. One way of visualizing a solution to this problem is to consider programs and data as residing in concentric rings of protection, the inner rings being protected against requests coming from the programs in the outer ones (Figure 1). A program in the professorial ring can write on the grade list, but a program in the student ring cannot. Special permission is required to allow a program in the student ring to "call" or execute a program in the professorial ring. In this example, student-ring programs are allowed to call the grading program but not to write on the grade list itself. Thus the grading program can act as a mediator between the student's program and the grade list, just as the operating system acts as a mediator between any user and any information he tries to access. A program

written by the student might attempt access to the grade list but would be rejected.

This scheme still places one restriction on sharing, and in particular it discourages a kind of sharing that one might well need in business applications. It is best illustrated by an example. Suppose that A has written a sorting program (or any other generally useful program) and B rents the use of it from A. He relies on the sorting program in constructing a package for file-manipulation; that is, the package often makes use of the sorting program. B desires to lease the completed package to C.

C, who will thus be using the sorting program along with the rest of the package, must approach A for explicit permission to use the sorting program. A would like to be able to say that B is free to pass the use of the program along to anyone, as long as B pays A for each use. Who uses A's program really doesn't matter; in effect, the user is B's program, and B should pay each time.

Such considerations have prompted the most recent proposal for a relaxation of restrictions on sharing. Instead of classifying programs and data according to membership in protection rings, this approach uses the idea of access paths linking programs to data and to other programs. Figure 2 represents the professor/student problem, and Figure 3 the arrangements between A, B, and C.

To be safe, this technique requires the user to specify not only which programs may call his program, and which programs may read or write his data, but also to what extent this permission may be transferred to other programs by the programs to which it is originally granted. Thus A may specify that any user of B's utility package may execute his sorting program. B, on the other hand, might stipulate that a program written by C may call the utility package only if C himself is using the program—that the right of access is not transferable.

Thus, at the present time, techniques of specifying and controlling access are known which seem to enable the user of a computer system to specify with fine discrimination just which programs of which users may have what access to which information; and special mediator programs can be written to enforce other conditions which must be met before access is granted, such as payment of royalty.

Ease of Use

The result is that the user is now presented with a collection of possibilities too complex for the human mind to manage. Responsibility for any sizeable collection of data (such as, one day, every family may keep on the computer utility) or for a collection of programs (such as the answering-service program that a software house of the future may rent out to families) brings with it a lot of work in the way of detailing access conditions. The user must be sure that the access he grants is neither too permissive nor too strict.

The existing MULTICS system at M.I.T. employs the concentric ring structure, with lists of persons who may obtain access, specifying modes of access available to each. Human errors in using the access-control procedures wasted much time and energy during the development of this system, although the people making access decisions were highly trained computer programmers.

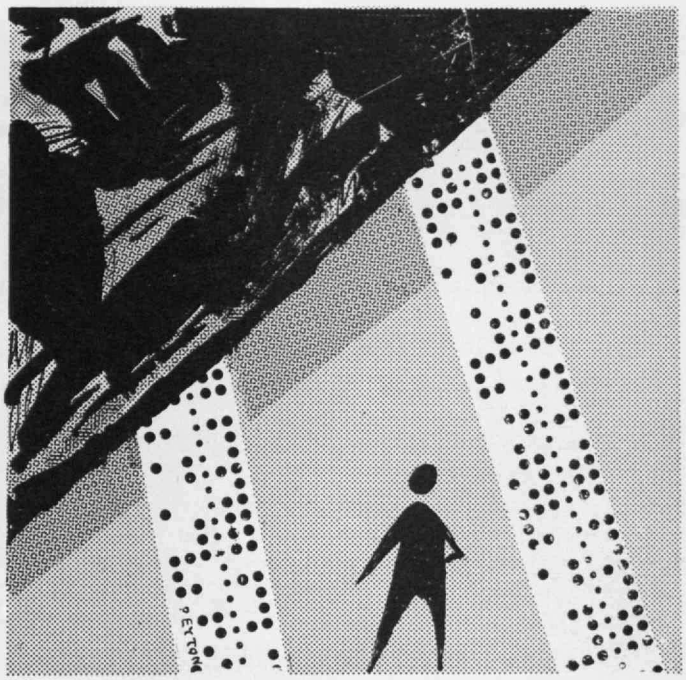
The nonexpert who uses a computer utility must have some easy way of deciding what access permissions he

should grant for any given piece of information. Operating systems of the future must provide him with a set of simple tools to help him do this. For example, the user might be asked to classify information as family-confidential, company-confidential, public/collect royalty, or nongovernmental use only. Such tools should never confine the user—the full power of the basic facilities which the system provides must remain available to him.

It should be possible for the computer to decide, when someone makes a request for access, whether to grant it to him. Currently the user must stipulate in advance just who may use information. Thus, when someone wants to rent the use of a program from someone else, he must first contact the person so that his name may be put on the access list. The computer is not being used to expedite the transaction. In the computer systems of the future it is quite possible that the person who wants to rent a program will request permission through the computer. The owner's permission-granting program informs the customer of the conditions of rental, asks if he is willing to rent under these conditions, and then adds his name to the access list and arranges for the payment of royalties. It could also put a note in the owner's "mail box" to the effect that so-and-so just became a customer for his program.

These, then, are the five requirements that will have to be met if the computer utility that we envision is to become a reality without endangering the rights of individuals in the exchange of ideas. If they are not met, then either the sharing of knowledge will be stunted, or, worse, those sharing it will live in a state of insecurity because the act of sharing is out of control.

The technical problems can be solved. Many already have been, and only the requirements of maximum protection and ease of use remain substantially unfulfilled. But just as important as solving the technical problems is ensuring that the solutions are widely published and are actually used in the construction of commercial systems.



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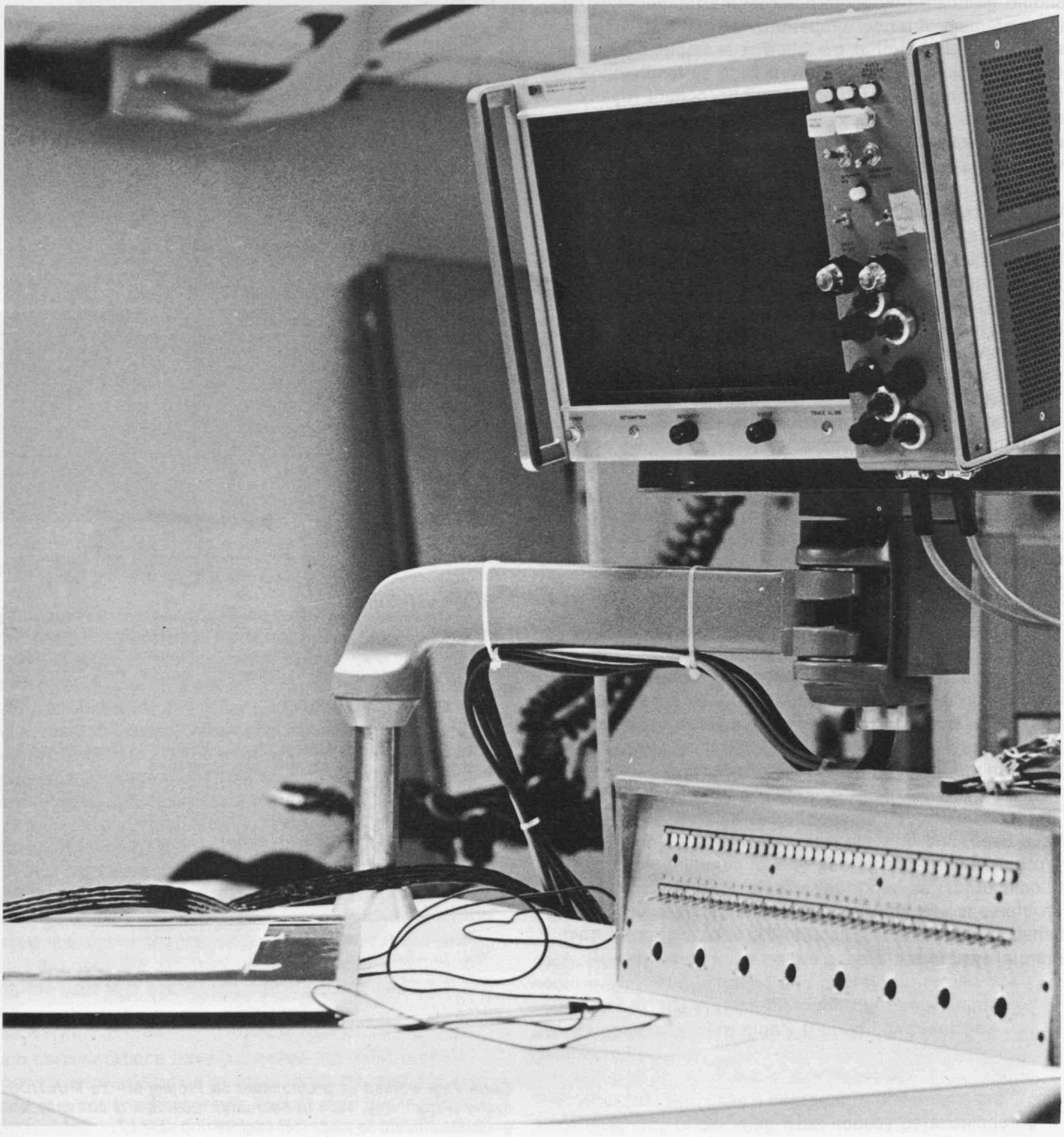
Dean Vanderbilt, "Controlled Information Sharing in a Computer Utility," M.I.T. doctoral thesis proposal, Department of Electrical Engineering, March, 1969, Chapter 1.

Carla Vogt worked as programmer on Project MAC's MULTICS systems from May, 1966 to February, 1969. She is currently a graduate student in electrical engineering at M.I.T.

"If we cannot say exactly what we mean by privacy, and for what reasons we value it, we are very likely to find ourselves, quite soon, in a world we did not really want."



The rights of privacy are not likely to be preserved in the absence of some clear definition of their nature. Here is an effort toward an agreed ethic drawn from principles laid down by Sartre

L. Alan Kraning
Graduate Assistant in Electrical Engineering, M.I.T.

Wanted: New Ethics for New Techniques

Anyone who reads a newspaper, or who watches television, constantly confronts new products born of scientific research—products which claim to improve health, increase longevity, relieve occupational tedium, or provide entertainment. Thanks to science and applied research, a continuing parade of such innovations and discoveries as penicillin, television, the automobile, air conditioning and high-speed computers has enriched and broadened man's endeavors.

These benefits, insofar as they are indeed beneficial, have not come into existence automatically. Technology is neutral, and in the absence of deliberate choice the score of its progeny would be (in the statistican's phrase) no better than chance—a random mixture of boons and curses. Every new technological possibility requires us to choose what use we shall make of it—if any.

Change is easy, but progress is not. Indeed, change not informed by conscious judgment is quite likely to cancel out the labors of previous generations (just as, in biology, mutations are generally harmful, because any viable species, as a result of natural selection, already has far more to lose than it has to gain).

"Solving" the Information Problem

The last 70 years have seen a doubling in the amount of information recorded since the beginning of history. The nature of our social institutions requires that information —the heart of the decision-making process—be handled accurately, quickly, and objectively. Computer processing, now cheap and widely available, "solves" this problem—solves it in the sense that it removes the most obvious symptom. But it provides at best a short-term relief from the overwhelming volume of "pending" information.

Unfortunately, computers accept only a standardized form of data; they can store only logical form, devoid of qualitative content. Electronic circuitry makes no provision for nuances, ambiguities, and meaning-in-context. Something is lost in translation from input to output, and if the intangible part of the information lost is relevant to a decision, the directions of policies involving computer-handled information can lose sight of the original human objectives. The threat to the context and meaning of information was heretofore unheeded by those who delegate their decisions to a machine.

Such ignorance can have subtle effects upon the structure of private and government decisions, as depicted by Orwell's automated culture of *1984.* If allowed to flourish unchecked and uncomprehended, the computer can in large measure dehumanize society (a) by removing possible nuances in meaning and (b) through standardization of form. Some people feel an instinctive revulsion when they learn that, for example, the class schedules of an educational institution are largely the work of a machine. Their reaction is reinforced if the schedules turn out to be absurd.

But our theme here is another kind of threat, also discussed by Orwell—a disturbance of the balance of power within society, coupled with the erosion of that personal, private world within which each man works out his own salvation. Democratic societies function because the power of government rests in the hands of those who are governed. The legal principles first enunciated by Mill and Bentham have guided both English and American law in the tradition of individual sovereignty; at the heart of such a system is the principle that a minimum of personal accountability is required—one is accountable to society only for those actions that could limit the liberty of others, and one gives to government only as much personal information as it really needs to carry out its democratically specified tasks. By denying knowledge of personal tastes and pursuits to governing officials, the system prevents excessive rights of power being given to local and national agencies; the autonomous, informed citizen constitutes the bulwark of the controlling forces.

Today, however, the sheer volume of information in use makes it impossible for the average citizen to inform himself of all relevant details of every issue. Consequently, the task of compiling, analyzing, and employing information—and hence the task of public decision making—is delegated to an ever smaller number of people. Given the speed and efficiency of large-scale computer systems, there exists a very real threat to any substantial control of the situation by the majority of individuals.

Unless a citizen has access to the same information and processing capabilities possessed by government and private agencies, his ability to participate in decisions affecting him, and consequently his ability to influence events, is greatly diminished (an obvious example being

credit information stored and propagated by various credit bureaus).

Concomitant with the issue of personal participation is the right of privacy, a value which until recently has been more or less presumed an a priori part of tradition and law. The relationships within all social and private agencies and governing groups depend upon a maxim which, in essence, implicitly directs all actions toward fostering protected communications among members, and between the group and outside parties. The restriction of communications with outside groups is a prerequisite for normal relations of trust between individuals and groups of individuals; it is also a requirement for individual control over private portions of one's life.

Because this need for protected communications is so fundamental to human relations, it behooves us to examine further the special effects computer technology can have upon trust, private interpersonal relations, and personal communication. This entails examining not merely the properties of computer systems but also our own needs. If we cannot say exactly what we mean by privacy, and for what reasons we value it, we are very likely to find ourselves, quite soon, in a world we did not really want.

The Vagueness of "Privacy"

The controversy precipitated by the 1967 hearings in Congress on the subject of personal privacy has generated a phalanx of literature in books, reviews, and research journals of many professions. Legal, physiological, psychological, and sociological considerations have contributed to a broad *functional* discourse on privacy, but as yet the philosophical justifications for fundamental rights to privacy remain sketchy, incomplete, and even contradictory. As a tool for legal action, present approaches often prove awkward, and thus far case results have suggested no single encompassing structure for future analysis and policy decision. A different train of thought, capable of shedding new light on the concept of personal privacy, could provide the necessary philosophical foundations for such a framework.

Much of the current justification for the right to privacy stems from the traditions of democratic states enunciated by John Stuart Mill. Accordingly, modern democracies all recognize *some* demarcation between activities subject to public control and scrutiny and activities for which the individual bears no public responsibility. But the rhetoric of utilitarianism suffers from age and from ambiguity spawned by nuances and changes in meanings of words. Contemporary existentialism suffers no such malady. For this reason—its contemporaneity—and because of its operability in conjunction with a pluralistic value system, existential thought may prove useful as an approach to the question of individual privacy.

The Chooser and the Object

Modern existentialism describes man in terms of two components, his subjective and his objective parts. Objective man is that portion which is factual—the body and the past; the objective is unalterable, fixed. Subjective man is that portion which is free to change, free to *employ* the objective portion of the individual in actions which alter the present environment. Sartre used the term consciousness synonymously with the subjective portion. Each individual human being embodies both objective and subjective components. The objective, factual part relates to man's past actions and the decisions which have guided the actions (incidentally, the word *fact* originally meant 'what has been done'); consciousness, on the other hand, relates to the future, in that through consciousness the course of events yet to come is conceived by, and executed under control of, the subjective.

The alteration of current conditions is effected when man the subject perceives a gap between what he feels the situation should be and what it really is in fact. Once he assumes a posture of change, he commits his resources and actions to the pursuit of his chosen change. The word *choice* is the key to action, for it is through choices of action in the past that the individual's present has come about. Given his present situation, man *must choose* his future; he is free to choose, he is indeed "condemned to choose."

Upon what basis does he make a choice? Man's absolute freedom leaves each choice unconstrained by a priori values or choices. At any given instant, choice of one particular action over alternative possibilities is subject to only one limitation, the "existential morality"; that is, any action chosen must not infringe upon the freedom of others to choose. Beyond this, the value of any choice lies only in its *being chosen,* not in any prior values which are assumed.

The above few words state the meat of Sartre's existentialism, with emphasis on three major departures from traditional philosophy. First of all, the idea that an action has value only once it is chosen reverses the popular outlook. Each individual subject, confined only by the "existential morality," is responsible for enacting changes as he sees fit. Any form of government which works "for the people" must therefore maximize the extent to which each individual may partake in the process of choosing the future. The subject/object definition is a new view of the human state. Man is both subject, defining his future through choice, and object. This division will be especially useful in the discussion of privacy. Finally, the idea of a condemnation to freedom, unmitigated by prior restriction and necessitating an arbitrariness in choice, defines the condition under which man must morally exist.

The Uses of Privacy

The right to be let alone has been secured in Western democracies primarily by restricting knowledge of private activities. Personal privacy can never be absolute, since society as a whole requires certain information for the efficient functioning of its government. The Census Bureau uses collected data for the formation of policies which accurately solve problems. In addition, social science research, which generates useful methods of coping with the environment, needs accurate data for testing hypotheses. Society also requires the control of those individuals who seek to steal, kill, rape or commit

other genuinely evil acts. Governments survey the activities of these persons with the hope of preventing further evil.

Apart from governmental needs for information, the individual's responsibility to disclose personal data depends upon which organizations and institutions he chooses to enter. It is between the individual and non-government institutions that problems are arising which cannot be settled using current notions of privacy.

The right to privacy is the right of an individual (group, organization, class, society) to decide for himself (itself) (1) to whom, (2) to what extent, and (3) for what purpose information about himself (itself) is to be disclosed. Seen from another point of view, privacy is the limiting of sensory and communicative interaction between two or more persons.

Professor Alan F. Westin, in *Privacy and Freedom,* mentions four functions that privacy serves to the individual —autonomy, emotional release, sheltered personality experimentation, and limited communication. The four functions interrelate, but this breakdown is most instructive for purposes of analysis. The first three functions apply to isolation of the subjective part of an individual; the last—and most important—applies when two or more individual subjects interact.

Autonomy

When isolated from the influences of outside parties, an individual (or group) has the opportunity to exercise whatever values and action he considers worthy, unhindered by pressures which might make him less able to choose as a free subject. The concepts of individual autonomy thus far enunciated by legal and sociological literature sometimes fail to take into account the necessity of individuals to perform actions which, while within the limitations of the existential morality, deviate from accepted social norms of behavior. These deviant actions are precisely what constitute the difference between an individual's subjectivity and the group's current norms. Without them, there would be only group life and no true individuality. A subject defines himself not only in view of his own past but in view of what he knows of other subjects. Given that the freedom of individuals to do so is desirable, an atmosphere conducive to maximum individual self-definition is required. Autonomy is the right to define one's actions, goals, and attitudes apart from the gaze and influence of others.

Emotional Release

As an individual proceeds through daily life, he assumes a variety of roles commensurate with the particular tasks he must perform. The acceptance of a role allows him temporarily to forget that he is free and to become, as it were, unconscious of his consciousness. The need for action requires such unconsciousness, for continous awareness of unrestricted choice is debilitating. Hence, one assumes a number of roles for the sake of constructive action—father, supervisor, teacher, defendant, husband, customer, and student, to mention some.

Continued performance of any role leads to loss of identity. On a lesser scale, each individual requires circumstances in seclusion where he can assert his own actions and hence define an identity of his own choosing. To allow such roles too big a share in one's life reflects the acceptance of a priori choices not necessarily made by oneself. Privacy permits the individual to divest himself of an assumed posture or role and to alleviate tensions created by the conflict between his personal attitudes and those demanded by the roles. (The novelist Kingsley Amis rose to fame by observing this aspect of life.) The analogy between acting and personal role playing is helpful, for in both cases, action (the script) dictated by someone else ultimately conflicts with the particular emotional needs of the individual reading the script.

Sheltered Personality Experimentation

An identity crisis confronts every individual, demanding that he define himself through his actions. Every individual requires time and place for planning as well as for sorting out the phalanx of information presented him by experience. He must evaluate alternative choices on the basis of past experience and upon what he desires in the future. In cases where he is uncertain, yet feels the need to take some action, he may wish to try out and establish the consequences of a decision before actually committing himself and assuming responsibility. Which college I attend, which job I accept, which city I choose to live in—all require careful consideration, evaluation, and some type of experimental evidence before a final choice is made.

The individual's need to explore and evaluate the worth of past choices must be made free from forces which tend to impose others' evaluations and perceptions. An individual can establish his identity—the sum of his choices—only in an atmosphere where his own perceptions dominate. (Of possible interest here is the recent finding that children whose *perceptions* are flatly denied by their parents—"You don't like ice cream"—tend to grow up schizophrenic, i.e., without a workable personality.)

Limited Communication

The self-image of an individual can be thought of as a series of concentric spheres containing information about himself, his perceptions of his environment, and his interactions with others. The degree of sensitivity increases as the center is approached. The core holds those secrets, hopes, and fears that no one other than the individual may know. Communication between two individuals exists only when there is a level of trust between them—that is, a mutual belief that despite personal knowledge disclosed by the one, the other will treat him as a free, independent subject and not utilize this knowledge to "objectify" him, constraining his future actions. (The interplay of partial secrecy and partial control is roughly what we mean by intrigue.) The level of trust is limited by the amount of knowledge one individual believes he may disclose and still be recognized and treated as a subject.

Privacy in terms of communications guarantees an atmosphere free from external intrusion in order that sensitive information may be disclosed among intimates and may be limited to those including the participating individuals. In this sense, a group of people, although individuals unto themselves, may be treated as a single complex personality with subject and object aspects. With this expansion, the three previously discussed functions of individual privacy may be extended to groups. Groups of individuals—whether it be newlyweds, a business, or a jury—need some degree of autonomy, emotional release from pressures, and sheltered exploration if they are to define a group identity and function in a chosen action.

In situations where one individual feels that he is endangered by another's knowledge of him, he may and must have the right to limit the degree of disclosure. Sartre discussed the "gaze," or look between two individuals, as an attempt by one to relegate the other to the status of an object—that is, to appropriate the subjective freedom of the one for use in the purposes of the other. This situation is one case of violation of the existential morality and accurately describes situations where a trust is betrayed. The gaze is in reality an expression of surveillance with ignoble purposes. Wiretapping devices, for example, invade a trust relation against the moral principle and should be prohibited in all cases except those in which surveillance of an individual is necessary for perpetuating the subjective freedom of others.

Selective limitation of communications to a chosen range of people allows a person to discuss various personal problems with many different people but without giving sufficient data to any one person to allow an attempt at objectification. To be totally identified and predictable is to become as an object—to be like a beaker of chemicals in an experiment, totally disposed to the whims of an experimenter. The scenario of *1984* serves reference enough to warrant prohibition of situations where total or near-total surveillance and identification is possible.

The Technical Barriers

These four functions thus describe how privacy, a state of existence controlled by the subject portion of man's personality, allows him to exercise his own choices free from the pressures of others and free from attempts by others to objectify him. Hence privacy is a condition or goal not in itself, but one which is instrumental in the attainment of further ends. In the sense that privacy is necessary for subjective freedom, to violate privacy violates the existential morality.

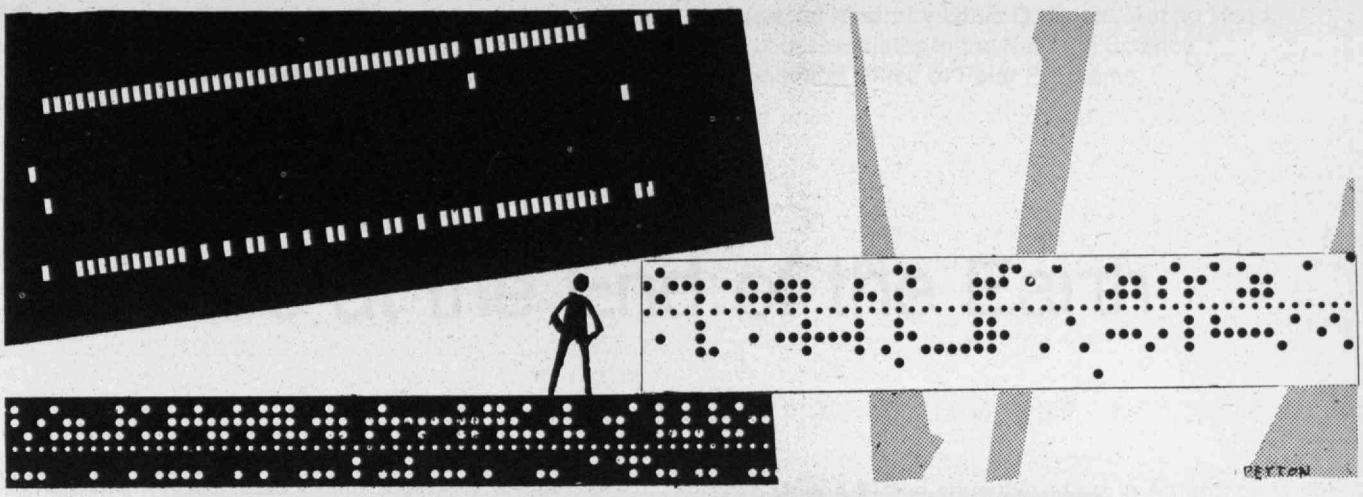
If we are to maintain a high degree of personal privacy as we apply machines to information-handling tasks of accelerating complexity, then legal and operational policies must be discussed and various alternatives examined in the light of some chosen set of requirements such as the above. And certain technical issues, which could be critical in determining what kinds of facilities are feasible, must be thoroughly researched. I should like to conclude with a brief discussion of the more important technical breakthroughs required to give us adequate freedom of choice.

Given that we wish certain facts to reach some people and not others, we must find methods by which machines can accurately identify people. On-line computer systems present a great problem here. If a user is at a remote on-line terminal, there is no known way to ensure that he is actually the person he claims to be, short of sending someone to the location to verify such claims. Any means of identification (passwords, voiceprint, fingerprint, TV image) which is converted into electric pulses between the remote terminal and the central processor can be electronically recorded through sensors attached to the transmission line. Any person having the recording can transmit the pulse sequence over the line and masquerade as an authorized user. Passwords used only once before discarding would prohibit masquerading fairly effectively, but such a scheme would be overpowering to implement on a large scale.

Terminal-user verification is but one of several open issues in the area of "access control." Recording devices can be used to obtain any data sent over a line, including passwords. Encryption is one possible means of combatting this operation (called piggy-backing), but coding and decoding are expensive in time and equipment.

The second key problem area is program verification. When a program is put into execution on a processor, how can one be sure that it behaves as intended? To be certain requires a knowledge of all possible states of the system; in practice this is impossible due to the huge number of states possible in a data center. The larger and more complex a program becomes, the more difficult is verification of its behavior. A program may behave as expected in a great proportion (>99.9 per cent) of situations but become erratic when confronted with certain data and machine-switch settings. And if a supervisory program, which guards the access control operations, becomes defective in any way, the usefulness of the protection mechanisms is imperiled. The problem of program verification has barely been enunciated; its solution is not close.

As mentioned previously, enciphering of information is



one means of protecting against unauthorized access. It is a problem area in its own right. Encryption techniques of varying cost, complexity, and effectiveness are available, the main criterion for success being that some "outside" person must be unable to decipher information at least until it becomes useless—encryption is not a cure, but a delay device. With sufficient resources and time, and enough data for pattern recognition, any encryption scheme can be broken. The one possible long-term use of encryption is in making illicit information excessively expensive to obtain. To this end, sensitive personal data may be thus protected, but the deciphering necessitated in normal authorized processing would introduce additional cost which might detract from a data center's claims to efficiency.

Perhaps the most basic problem—it is the classical task of the librarian, but in a new form—is how to organize the collection of data stored in a data center. What is important is the *relation between* data. A file with a name or social security number has much greater importance than a name alone or the remainder of the file alone; the total means far more than the sum of its constituent parts. We would like to store only one copy of any piece of information—which will thus have only one "address"—but what emerges from this address has to depend on who is applying for it and for what purpose. The idea of multiple copying, different users getting different versions, was one way of affording protection, but it can no longer be counted upon. Such questions as "What is the allowable size of a single logical unit of data?" and "How can any arbitrary unit of information be selectively shared yet protected against encroachment?" are largely unanswered.

The M.I.T. MULTICS system circumvents this problem by using the ring concept discussed in the accompanying article by Carla Vogt. In this situation, a file or portions of a file can be protected by allowing entry only through certain pre-written, selected programs. A user wishing access must have such a program, approved by some authority, written by a party not affiliated with him, and verified by someone else. The costs of bureaucratic red tape may drown the project's potential value. However, to date MULTICS appears to have the best answer to sharing.

Once these problems are sufficiently "solved," once the cost of positive social progress is made low enough both to allow computer-aided bureaucracy and to ensure individual autonomy, and once we have agreed on the meaning and purpose of that autonomy, then the idea of computer-utility/data-bank installations can be morally and philosophically justified. Until such time, however, the best role of the computer is still an open, unresolved question.

Suggested Readings

Jean-Paul Sartre, *L'Etre et le Néant,* Gallimard, 1943.

Alan F. Westing, *Privacy and Freedom,* Atheneum, 1967.

Kenneth L. Karst, " 'The Files': Legal Controls over the Accuracy and Accessibility of Stored Personal Data," *Law and Contemporary Problems,* Vol. 31, 1966, pp. 342-376.

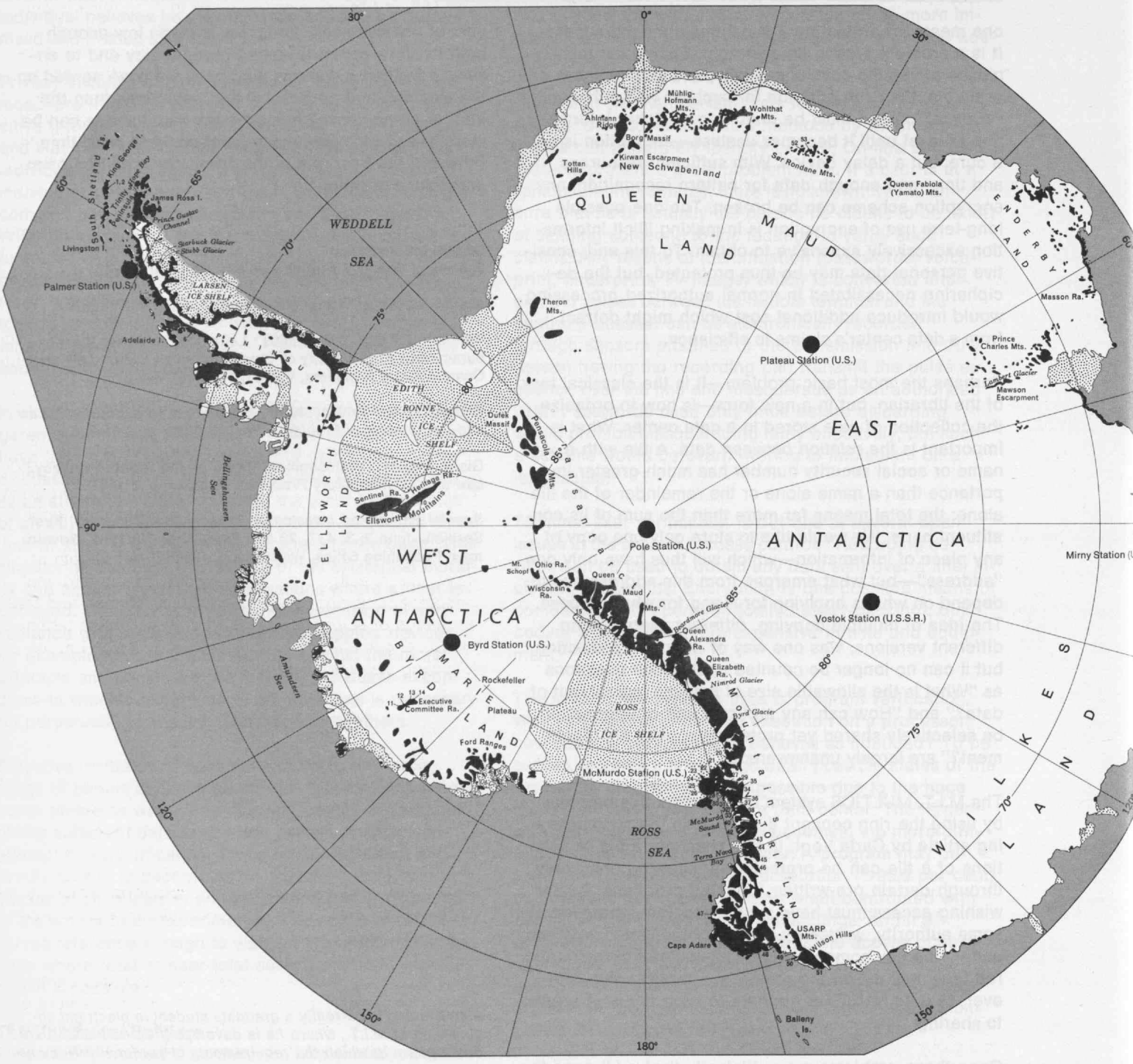
Edward Shils, "Privacy: Its Constitution and Vicissitudes," *Law and Contemporary Problems,* Vol. 31, 1966, pp. 281-306.

Glenn Negley, "Philosophical Views on the Right to Privacy," *Law and Contemporary Problems,* Vol. 31, pp. 319-325.

Special Enquiry on Invasion of Privacy, 89th Congress, First Session, June 2, 3, 4, 7, 23 and September 23, 1965, Government Publishing Office, Washington, 1966 (79-485-0)

Alan Kraning is currently a graduate student in electrical engineering at M.I.T., where he is developing an administrative data system in which the requirements of personal privacy are paramount.

Under terms of the Antarctic Treaty, 16 nations have now agreed that the Antarctic will be used only for peaceful purposes and that scientific personnel and results will be exchanged freely among them. The map, taken from Folio 7 of the American Geographical Society's Antarctic Map Folio Series, shows only the scientific stations discussed by Dr. Louis O. Quam and his associates in the accompanying article; other stations have been established by the United Kingdom, France, New Zealand, Argentina, South Africa, Japan, and Australia.



Research in Earth's most hostile environment is changing our concepts of climate, evolution, and the history of the planet upon which we live

A special report by Louis O. Quam, Acting Head, and his associates in the National Science Foundation Office of Polar Programs

Science at the End of the Earth

Antarctica has the most hostile environment on Earth, and the primary objective that has drawn man to its frozen shores is scientific discovery.

The Antarctic is literally the end of the earth, with no permanent population, no proven economic mineral deposits, and little of current commercial value. The men and women of a dozen countries who go there for the uncomfortable summers, and stay through the hardest winters known to man, with scientific equipment, ships and planes, vehicles and dogs, do so because Antarctica is part of the earth, and to understand Earth we must know all its parts.

The Antarctic can be beautiful, fascinating, difficult, and intractable—all at the same time. If research efficiency can be measured in some unit such as "data bits/dollar," the Antarctic is a very expensive place to do research. Research which is performed south of 60° not only demands the money and man-effort explicitly needed for the research but also the money and man-effort for logistic support of the scientific party.

In looking back, it is now easy to see how research in Antarctica may help solve problems of broad significance, but earlier scientific explorers seldom aimed at these results. The basic groundwork they provided was usually done for the local knowledge that was to be gained. In the last few years, however, scientists have built on these foundations and have discovered keys of worldwide significance that have been instrumental in the development, for example, of the new global tectonics that has revolutionized the earth sciences in the 1960's.

The United States scientific effort in Antarctica is currently carried out by about 200 scientists and technicians from some 40 universities, 10 research institutions, 7 government agencies, and 5 industrial laboratories. The funding and management of the U.S. Antarctic Research Program are provided by the National Science Foundation at an annual level of about $7 million; logistical support is furnished principally by the U.S. Naval Support Force, Antarctica.

In supervising the Antarctic science program, the National Science Foundation consults with other federal agencies and receives advice from the National Academy of Sciences' Committee on Polar Research, which serves as the voice of the scientific community. This committee also represents the United States on the nongovernmental international Scientific Committee on Antarctic Research, which coordinates the research activities of the 11 nations presently in Antarctica.

These activities are conducted in accordance with the Antarctic Treaty, signed in December, 1959, by 12 participants in the International Geophysical Year program in Antarctica and since acceded to by four additional nations. This treaty guarantees that Antarctica will be used only for peaceful purposes; assures freedom of scientific investigation; and provides for international cooperation, exchange of scientific personnel, and free exchange of scientific results. It is under these terms and arrangements that the activities described in the following statements are conducted.

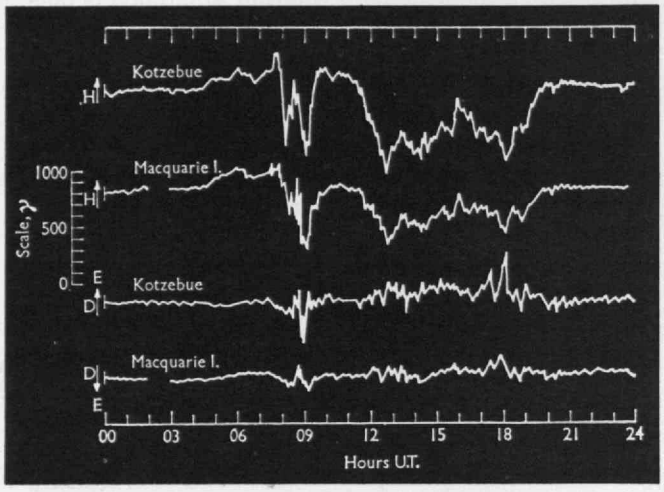
The Atmospheric Sciences at the Ends of the Earth

Ray R. Heer, Jr.
Program Director for Antarctic Atmospheric Sciences
National Science Foundation

The atmospheric sciences program in Antarctica is largely aimed at studying and understanding the solar-terrestrial relationship. There are two primary reasons for going to Antarctica: to obtain a sufficiently high count rate to study low-energy phenomena in the atmosphere from a reasonably stable platform which is independent of nationalistic considerations, and to study conjugate phenomena.

To understand the first of these—and to some extent the second, since it is an expansion and refinement of the first—consider the space occupied by our solar system. It is well known that the sun is an omnidirectional electromagnetic radiator, emitting over a wide spectral

This record of magnetic variations (H = horizontal field, D = declination) at Macquarie Island, the British station in the sub-Antarctic, and Kotzebue, Alaska, make it clear that the two stations lie at either end of a magnetic line of force—that is, are at geomagnetic conjugate points on the earth's surface. Geomagnetic disturbances show good correlation at local night time at conjugate points in the north and south polar regions; but during day time, and when magnetic storms take place, the correlation becomes poor. (Chart: Antarctic Research, ed. by Priestley, Adie, and Robin)



range; it is less well known that the sun also emits, or evaporates, charged and uncharged particles. The charged particles, most of which are protons or electrons, are the most interesting. Recall that charged particles in motion give rise to an indigenous magnetic field. In the case of the sun, the particles and fields constitute what has come to be called the solar wind. As this wind approaches Earth, the terrestrial magnetic field acts as an energy analyzer, so that successively lower-energy solar particles approach sea level as the measuring point moves from the equator toward the poles. Since there are many more low-energy particles than high-energy ones, the flux of charged solar particles which can be measured is higher in Antarctica than at lower latitudes.

The second prime reason for Antarctic observations is to perform research at conjugate points, these being defined as the two points, in opposite hemispheres, at which the ends of a magnetic line of force intersect the earth. Simultaneous measurements at the true ends provide information about the shape and dynamics of the earth's magnetic field as it interacts with the solar wind. In the past, it was assumed that all of the terrestrial field lines are closed on themselves; but today it is generally accepted that some of the field lines which have been swept back into the magnetospheric tail are not closed on themselves. It is possible to use conjugate measurements to determine whether a particular location is in a closed or open field line situation. This would be done by observing a phenomenon known to exhibit conjugate characteristics; if it does not exhibit simultaneous, more or less identical characteristics, then the observing stations are not conjugate.

Studies of Auroral Phenomena

Aurora studies may or may not be concerned with conjugacy and they may be concerned with conventional or polar cap type aurora. In the northern spring of 1967 and 1968, a cooperative effort involving the Geophysical Institute of the University of Alaska, the Los Alamos National Laboratory (A.E.C.), the U.S. Air Force, and the National Science Foundation provided some first-time information about how aurora conjugacy moves about with geomagnetic activity. In both years, instrumented C-135 aircraft flights were made from 50° geomagnetic latitude to about 67° geomagnetic latitude along a geomagnetic meridian, the flight limit being set by the availability of suitable landing fields, especially in the Southern Hemisphere. The 1967 flights took place during relatively quiet geomagnetic times, and the 1968 flights, made during a period when the average activity was higher, covered a variety of aurora intensities. The 1967 data from the two hemispheres presents an impressive argument for the existence of aurora conjugacy outside the polar cap and for the disappearance of conjugacy as one approaches the zone of maximum aurora frequency during periods of solar activity. Data from these flights are now being analyzed to establish when and where conjugacy does exist and thus to describe the magnetosphere better.

Another aurora investigation concerning conjugacy, but at a single set of points, is directed by Peter Millman at Byrd Station and its conjugate, Great Whale River, Quebec, Canada. This program, which is part of the international cooperation effort, uses identical instrumentation and simultaneous film development and analysis to determine when conjugacy exists at the two stations. The effectiveness of the program is reduced by the intractable nature of the Antarctic environment; though it has been feasible to operate a second station at Belcher Islands in Hudson's Bay, near Great Whale Station, to detect movement of conjugacy, it has not been possible to do this in the Antarctic. The analysis has established that conjugacy moves as much as 7° in geomagnetic longitude and 2° in geomagnetic latitude, and that it sometimes disappears completely. This last is interpreted as a manifestation of the field lines being swept back into the geomagnetic tail.

Both of the foregoing examples were concerned with the conventional auroras. Professor S.-I. Akasofu of the Geophysical Institute of the University of Alaska is investigating the behavior of midday polar cap aurora above South Pole Station. The Pole Station was chosen as the base for the investigation because its geographical position offers long observation periods for midday polar cap aurora. This is a form which, unlike aurora-zone aurora, is generally aligned with a geomagnetic meridian and may make rapid excursions toward the geomagnetic pole. Study of this type aurora is providing better understanding of polar magnetic substorms and sudden storm commencements. This is a one-ended study; the conjugate point, Frobisher Bay, N.W.T., Canada, is, of course, inside the aurora zone; but, because of its geographical position, it does not enjoy the

long periods of darkness needed for this particular investigation.

Photon Spectra and Solar Photon Flux

Byrd Station is well located to measure polar cap absorption of low-energy solar protons and to compare the absorption—which is a measure of the total path traversed by the charged particles—with other atmospheric physics parameters. Dr. George Reid and his group at the Environmental Science Services Administration (E.S.S.A.) Research Laboratories, Boulder, Colo., have been measuring galactic noise and interpreting this miscellaneous emission from outside the solar system in terms of ionospheric absorption at the Byrd, Pole, and McMurdo Stations and, as part of the international cooperation program, at Vostok, a Russian Station. At all of the stations except Byrd the procedure has been to measure the absorption directly overhead, but at Byrd the experiment is more sophisticated. There, five antennas were beamed, respectively, to the vertical and to 45° with the vertical along the four cardinal geomagnetic directions, while at Great Whale River, the Byrd conjugate, a single riometer is beamed vertically. The instrument is most sensitive to ion density changes in the D-region, around 90 km.; it follows from the geometry that the four 45° antennas look at the D-region in four directions about 90 km. away from Byrd Station in the four cardinal directions. By comparing the data from each of the five Byrd antennas with that from the single antenna at Great Whale River, it has been possible to learn something about how conjugacy moves about with geomagnetic activity.

The understanding of this riometer data was enhanced by another E.S.S.A. experiment. Wallace Campbell and his group are primarily interested in micropulsations, and they operate three-component air core magnetometers at Byrd, Pole, and McMurdo Stations to study electromagnetic phenomena in the 3×10^{-3} to 3 Hz frequency range. At Byrd, in addition, they operate an array of five photometers, each photometer filtered to 4,278Å and pointing in the same direction as the riometers. The riometers and photometers are sensitive to phenomena of different energies which may occur at about the same height in the atmosphere; so by comparing the two experiments, it has been possible to learn considerably more about conjugacy and its energy dependence over a wider range than could have been accomplished with a single experiment. Another D-region riometer experiment is conducted at McMurdo Station and its conjugate, Shepherd Bay, N.W.T., Canada, under the direction of Andrew Masley of the McDonnell-Douglas Astronautics Co. The experiment is rendered unique by its high geomagnetic latitude and the inclusion of a number of auxiliary detectors which insure that the effect being measured is indeed a solar proton event and not a magnetic storm. The results of this program have provided information about the proton spectra, the alpha/proton ratio, and the flux from various solar events. The same group has particle counters on the satellite OGO-F, which was successfully launched in June, 1969, measuring the proton flux and spectra. These data will corroborate, or correct, the conclusions gained from the ground-based data. The same data will also be used to calibrate the riometers.

Ionospheric Electron Densities

One of the oldest and most productive programs is the ionosphere and magnetosphere research directed by R. A. Helliwell of Stanford University. Beginning in 1960 and continuing to the present, Dr. Helliwell and his associates have concentrated on very-low-frequency measurements—though they have also made measurements across a wide range of the electromagnetic spectrum in order to compare and correlate phenomena. Over the decade they have operated experiments at four Antarctic stations and aboard the U.S.N.S. *Eltanin,* and they are now concentrating their efforts at Byrd Station, using as well the Canadian Alouette I and II satellites (as topside ionosphere sounders) and the OGO satellites (to measure particles and fields), the data from the satellites being telemetered to Byrd Station.

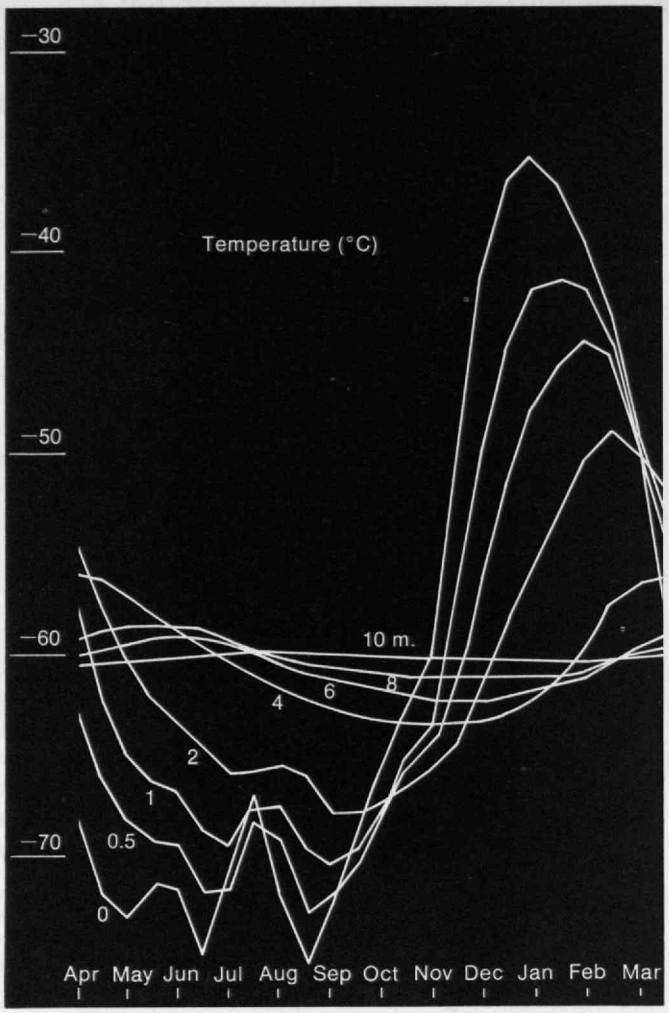
The objective of this Stanford research has been to learn about the spatial distribution of electron and ion densities and how these change with time and with solar activity. In particular the Stanford group has been most interested in the *whistler* signal, the result of a sferic, most probably a lightning discharge, which emits large amounts of electromagnetic energy across a wide spectral range. The group has been measuring whistlers at a multitude of terrestrial observatories for at least 15 years. Their particular interest derives from the fact that the very-low-frequency component of this electromagnetic energy becomes extremely field-guided. As a result, one has a high degree of confidence about the path through the ionosphere and magnetosphere followed by any particles on which a measurement can be made.

The most notable result of the program has been the discovery of the plasma pause, an ionospheric region in which the electron density changes rapidly with height, varying by an order of magnitude in a fraction of an earth radius at the equator and giving rise to an abrupt change in the propagation characteristics of the radio spectrum. The Stanford group's measurement of the fine structure of electron density versus height in this region of discontinuity, about four earth radii above the earth at the equator and approaching the earth in polar latitudes, fits well with current thinking about the solar-terrestrial relationship and the shape of the magnetosphere and the magnetospheric tail.

A portion of the atmospheric program at the Byrd Station is based upon the Longwire Antenna, two crossed (90°) dipoles 9 and 21 mi. in length laid on the ice, their center about 12 mi. from Byrd Station; the long leg (21 mi.) is oriented along a geomagnetic meridian. As far as is known, these are the longest horizontal dipoles on earth suspended over a homogeneous medium. The two antennas have been used to verify or refine antenna theory, to determine dielectric properties of the 7,000-ft.-thick ice layer at Byrd Station, and to determine the ionospheric ion density as a function of height and how it changes with solar position and activity.

Possibly the most dramatic findings have been how densities in the D-region change during events asso-

Plateau Station in the Antarctic was for three years the coldest inhabited spot on Earth. The chart shows the temperatures measured over the year 1967-68 on the surface and at specified depths in the snow—data important for studies of radiation transmission in the snow and of conduction and convection in snow cover.



ciated with polar cap absorption.

The lowest energy particles, regardless of origin, do not reach the earth's surface. Their effects may be measured remotely, as in the projects already mentioned. But balloon-borne instruments floating in the high stratosphere (30 to 50 km.) and sounding rockets reaching 50 km. into the ionosphere have been operated from Antarctica for direct observation. These in situ measurements are particularly important since the upper polar atmosphere in general, and the mesosphere (50 to 90 km.) in particular, is dominated by effects of the energetic particles bombarding it. The effect of the geomagnetic field upon the motions of charged particles is such that only in the polar regions can the properties of the lowest energy and most variable parts of the spectrum be directly investigated relatively close to the surface of earth.

No completely satisfactory understanding based on the present-day theory of a magnetized plasma has yet come forward, but improvement in the quantitative observations continues. These observations have found use in the empirical description of (1) solar particle emissions from energetic flares, the propagation of these charged particles toward earth through the interplanetary medium, and their entry into and motions and effects within the terrestrial magnetosphere; and (2) energy transfers from the solar plasma to the magnetosphere which manifest themselves in worldwide geomagnetic storms, the precipitation of energetic particles into the northern and southern auroral zones, and in other ways.

James Barcus and his group from the University of Denver have enjoyed two successful seasons of data collection from high-flying balloons above Byrd Station. Low-speed, variable winds at the 90,000-ft. level have made possible reception of telemetered data from the same balloon for more than 24 hours. Dr. Barcus and his group have used a variety of detectors to learn about the flux and spectra of solar particles and how the temporal and spatial distribution varies. They have made measurements over a sufficiently wide energy range to include the prompt relativistic particles associated with polar cap absorption and the less energetic nonrelativistic particles associated with magnetic storms which receive their acceleration, at least in part, in the vicinity of earth.

The Earth's Coldest Desert

Plateau Station operated for three years, closing in January, 1969. It is one of the coldest spots on earth, with an average temperature of nearly — 70° F., where the recorded temperature has never gone above 0° F. and where, on July 20, 1968, was observed the lowest temperature (— 123.1° F) ever recorded at a U.S. station. It is located at an altitude of nearly 12,000 ft. (of which some 10,000 ft. consist of ice and snow) above sea level; the combination of elevation and average temperature provide an equivalent pressure altitude of 14,000 ft. (vacuum tins packed for sea level let air out, not in, upon opening!). At Plateau the lack of oxygen is as much or more of a challenge than the cold temperatures. The extremely harsh environment hampered the scientific effort, increasing several fold the time required to complete routine outdoor work and to correct instrument failures and other operational difficulties unique to this part of the world.

In such an environment it is reasonable to expect that meteorology was one of the areas of greatest interest, and, in fact, a multilaboratory meteorology research effort was conducted over the lifetime of the station. Routine weather observations were made every three to six hours for the U.S. Weather Bureau in an attempt to establish the climatic characteristics for this part of the continent and to study weather changes on a daily and seasonal basis. Since the Russians had previously collected some data on the plateau, it came as no surprise to find that Plateau has, essentially, a desert

climate. The annual net accumulation of "snow" is less than three inches, and most of this is the result of nearly constant fallout of extremely fine, nearly invisible ice-crystal precipitation. Seldom influenced by the intense storm systems prevalent along the coastal areas of the continent, Plateau's winds are generally light to moderate, averaging about 10 knots and for the most part very constant out of the northern sector. Summertime temperatures seldom are above −20° F., and minimums of −100° F. or colder are frequent during the winter. Midwinter warming trends are noted from time to time, characteristic of the Antarctic in general.

Refraction studies were also carried on for the U.S. Weather Bureau at Plateau Station in an attempt to analyze the vertical temperature profile near the ground by using a system of lighted targets and recording the geometrically changing optical effects with a camera. In addition, in an attempt to learn more about the great Antarctic temperature inversion as well as the radiation budget of the upper atmosphere, several series of radiometersonde balloon flights were made from Plateau Station during the dark months, May through August. A temperature increase of 50° F. was sometimes observed in the lowest half-mile above Plateau.

A more detailed picture of the lowest portion of the temperature inversion was obtained as part of an ambitious micrometeorology program carried out by the U.S. Army Natick Laboratories with the aid of a 32-m. tower instrumented at various levels to monitor temperature, wind speed, and wind direction at Plateau Station; complete tower profiles, together with a 10-m. subsurface temperature profile, were recorded automatically. Dramatic temperature inversions of as much as 30° F. between the bottom and the top of the tower were noted on several occasions and directional wind shifts of 90° or more were measured between the tower base and top. To obtain a more complete picture of the energy budget, an extensive radiation program was carried out in which specialized tower mounted radiometers were used to measure incoming and reflected long- and short-wave radiation.

Representatives of the Meteorology Department at the University of Melbourne used thermocouples and thermopiles buried at various levels down to 10 m. to measure subsurface temperature and heat flux profiles. All of the measurements together provide information about the Plateau environment from 10 m. below the ice surface to 3 km. above it and will aid in defining the energy budget at the snow-air interface.

Biological Sciences: Ecosystems for Survival in Adversity

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Because Antarctica is far from being a perfect continent, biologically speaking, its affinity for biological research varies considerably. Having never been permanently inhabited by man, the continent holds very little promise for archeology. The rich environmental association of plants and animals so prominent in freshwater systems is completely lacking in the absence of rivers, lakes, swamps, and marshes. There are no forests or grasslands. The terrestrial vegetation consists entirely of mosses, lichens, hepatics algae, and fungi. Two flowering plants adorn the seventh continent—but only along the northernmost extension of the Antarctic Peninsula. The dominant terrestrial animals are mites and insects, since the vertebrates, both sea birds and seals, which visit Antarctica during the austral summer, use the continent only for breeding and look to the sea for subsistence.

In view of these shortcomings, one may well ask what biologists find so attractive in this land. One answer lies in the very simplicity of the terrestrial and marine biota. Another lies in the strange and precise adaptations of Antarctic organisms to their environment. These adaptations emphasize the marginal conditions under which life has evolved and exists; and an understanding of survival under these conditions has important implications for that day when even an ice-covered continent may be occupied by man.

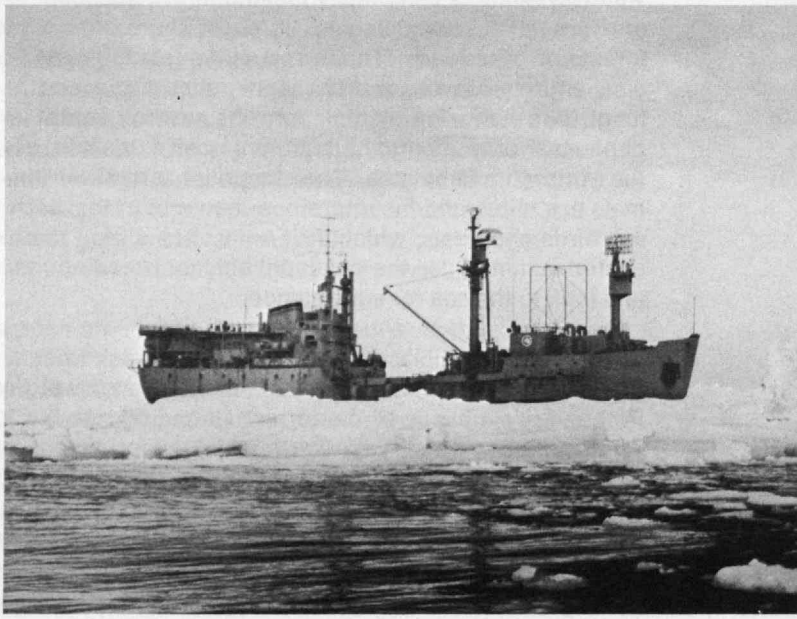
Antarctica is the only unexploited and untouched land on the planet, thus providing a standard for measuring the spread of agricultural, industrial, and nuclear pollutants in the global ecosystem. The unique provisions of the Antarctic Treaty of 1959 assure individual scientists international cooperation; and under the measure agreed upon for the protection of the flora and fauna, conservation on a continental basis is, for the first time, agreed upon by international treaty.

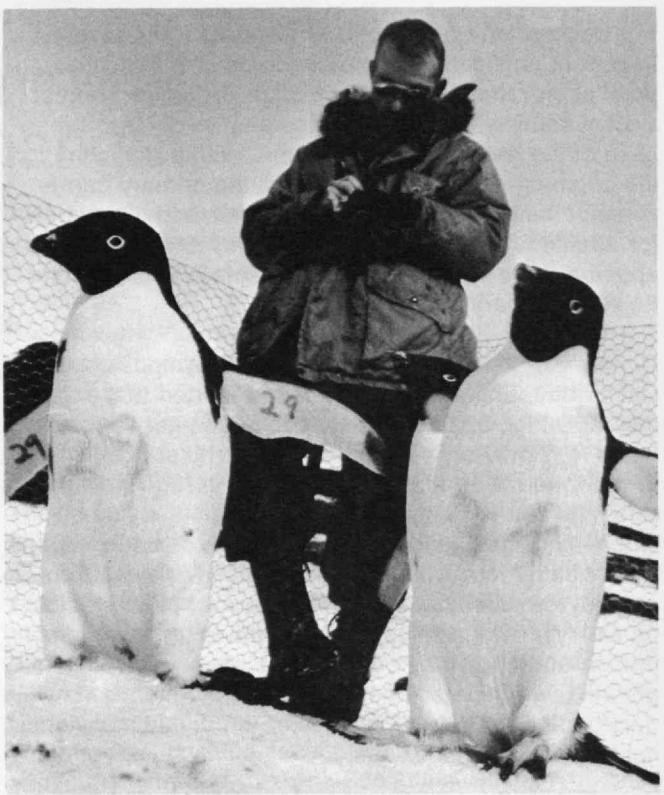
Antarctica provides a unique laboratory for the study of low-temperature effects on biological reactions and for investigations of simple ecosystems, population dynamics, and social behavior in large bird colonies. The preeminence of Laboratory Antarctica lies in the great abundance of life in the seas around the continent and the contrasting impoverished and marginal terrestrial fauna and flora; in the relatively small numbers of species but great hordes of individuals; in the simple and direct food chains of both terrestrial and marine ecosystems; and in the specialization of many of its animals—flightless and winter-breeding penguins, deep-diving seals, hemoglobin-free fishes, and microorganisms of the ahumic and primitive soils.

Ecosystem of a Productive Ocean

Hedgpeth, in Folio 11, Antarctic Map Folio Series, describes the waters of the Antarctic as comprising a relatively uniform biogeographic region characterized by a very high primary productivity associated with a rich zooplankton population. El-Sayed estimates that the waters south of the Antarctic Convergence, which

Visitors to Antarctica without exception find it a compelling land of great beauty and contrasts. The photographs show the electronic gear of an atmospheric physics laboratory at Byrd Station; ground-temperature measurement equipment (Robert Black and Carl Bowser, University of Wisconsin) in the Taylor Mountains: the wild beauty of McMurdo Sound; the oceanographic research vessel Eltanin; *a view of Antarctic transportation; filling a helium upper-atmosphere balloon near McMurdo Sound; a research study of penguin habitat; the Soviet station at Molodezhnaya; and a microclimate study of primitive insects resident in an ice-free range (Kelly Rennell and Keith Wise, Bishop Museum—Hawaii). (Photos: National Science Foundation and H. Leroy Scharon, Washington University)*

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constitute 5 per cent of the world's oceans, support a gross production in the order of 20 per cent of the world's oceans. On the basis of unit area, this means that the Antarctic is 400 per cent more productive than the rest of the oceans.

The Antarctic marine ecosystem is subject to harsh environmental conditions. Populations of successful species tend to become phenomenally large—as the whales—or dense—as the swarms of krill; while the ecosystem itself is composed of short food chains, as may be seen by the dependence of baleen whales on krill. Because the primary productivity is highly seasonal, the consumer species are forced to migrate and seek other food sources or to remain semidormant during the long austral winter.

The decimation of Antarctic whale stocks has several important implications. One concerns how this whale population relates to the population dynamics and ecosystem stability of the krill, since it is so close to the base of the Antarctic food pyramid. With a reduction in the catching of whalebone whales, the primary carnivores of the phytoplankton-grazing krill, and the search for additional world food sources, harvesting of krill appears to be one way to take advantage of the Antarctic sea's primary productivity.

During the 1968 Antarctic Biological Symposium at Cambridge, England, the Russians reported that experimental fishing attained a yield of six tons per 30-minute trawling. However, because of their critical position in the food chain, the harvesting of krill requires further scientific study, simply to determine what may be optimum sustained yield and so to avoid exhausting this great natural resource. Good ecological work rests on good systematics; and in the Pandora's box of studies on ecosystem dynamics, the basic need for more information on life histories, breeding biology, rate of growth, and dispersal mechanisms is pertinent to understanding the role of species of the multidimensional net that populates the seas.

Physiological Adaptation to Cold

Morphophysiological adaptations in Antarctic organisms have been the basis for much of the work by terrestrial and marine biologists. The terrestrial environment on the continent—temperature, humidity, and isolation extremes—has been compared with the surface conditions of Mars. Temperatures within the range of 30° C. to − 80° C. in Antarctica are similar to the Martian range of 30° C. to − 100° C. However, after studies on the environment and soils of the Dry Valley in Antarctica, relevant to the detection and quarantine of life on Mars, the Jet Propulsion Laboratory reports that the availability of salt-free moisture is an important factor in the presence or absence of soil microorganisms.

Gannutz's observations of the metabolism of lichens and mosses over 320 uninterrupted days at Palmer Station reveal that Antarctic plants do demonstrate variations in metabolic capability throughout the year. Lichen photosynthetic rates average five times respiration rates during the summer; respiration rates decrease as temperatures approach freezing. In general, lichens are better adapted physiologically to Antarctic stress conditions than mosses; the latter cannot photosynthesize at temperatures below − 4° C. or in light conditions below 0.1 g. cal./cm.^{2}/min. Lichens produce great quantities of chemical compounds which are deposited within the thallus, and these in part prevent the thallus from freezing at extreme temperatures.

Some of the most pertinent work in cold adaptation in Antarctic fishes began with Wohlschlag about 1960. He noted that, though the sea water under fast ice in McMurdo Sound was nearly 2° below the freezing point, with a variation of less than .1° throughout the year, certain species of fish remained active. Somero and DeVries, students of Wohlschlag, later found that the temperature inside the fish varied by less than 1° from the sea water, showing that the fish were truly cold-adapted. It was also demonstrated that the lethal warming point was 6° C. and that the higher temperature affected the brain.

In studying the freezing resistance in *Trematomus,* DeVries observed that most of that part of the serum freezing point depression not due to sodium chloride was due to high-molecular-weight organic compounds which he provisionally named "antifreeze." He determined these compounds to be 50 per cent protein and 25 per cent carbohydrate by weight molal basis, a thousand times more effective than glucose in depressing the freezing point of water. Fish of the genera *Liparis* and *Rhigophila* sustained supercooling to respectively .4° and 8° C. largely by remaining in deep water (500 to 600 m.) where ice formation does not occur. Deep-water populations of *Trematomus* were found to have serum freezing points 0.1° C. higher than those in shallow water, as well as lower concentrations of nitrogen, protein, and carbohydrate.

Other Biological Research

Kooyman first reported that the Weddell seal can remain submerged up to 43 minutes and reach depths of 600 m. Observations of pregnant seals by Elsner indicated that even at an advanced stage, pregnancy was no disadvantage and that in this condition females make 40- to 50-minute dives. In assessing mechanisms involved in the tolerance to hypoxia during prolonged dives, it was found that the blood O_2 store available during a dive is 2.5 to 4 times larger than in terrestrial animals and 1.5 to 2.5 times larger than in the harbor seal with moderate diving ability. While the Weddell seal has adaptive mechanisms to delay the onset of anoxia during diving, these do not prevent anoxia from developing during a maximum dive.

Because they congregate in large colonies, are relatively long-lived, cannot fly away, are unafraid of man, and show a strong attachment to breeding areas, penguins are ideal birds for ethological and population studies. Studies by Sladen based on data obtained from 25,083 penguins banded at Cape Crozier since 1960 reveal that only 17 per cent of the three-year-old breeders produce a two-egg clutch, while about 70 per cent of the four- to five-year-olds produce full clutches.

Penney arranged to release in the Ross Sea Adélie penguins obtained near the Mirny Station, a quarter of a continent away, and found that one bird returned to its colony in 12 months after traveling more than 4,500 km. His subsequent work with penguin navigation revealed that the Adélie possesses a well-developed sun azimuth orientation mechanism, and that this orientation is a population variant dependent upon time clues at the home rookery. This year, Penney transported in 58 hours five matched pairs of Adélies from Cape Crozier to a snow-swept field in South Dakota to see if they could steer a straight course in the Northern Hemisphere with respect to their home longitude in the Antarctic. In 12 of 13 releases, the change in direction was clockwise and on an order of magnitude approximating the expected rate of 30°.

Pollution is a very major international issue, and the extent to which pollution has affected the biosphere was clearly stated by Sladen, who in 1965-66 reported finding DDT and its residues in the fats of Adelie penguins and a crabeater collected in the Ross Sea. George and Frear confirmed his report and noted the presence of organochlorine compounds in skuas and in the fish, *Rhigophila*. The presence of these pesticides hundreds of miles from places where they were used was not attributed to atmospheric dispersal. The answer seems to lie either with pelagic marine organisms drifting in ocean currents or the ocean currents themselves, but the result appears to be a concentration in the food chains.

Earth Sciences: Confirming Continental Drift and Change

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Each of the broad, overlapping fields of the earth sciences in the Antarctic—geology, geophysics, glaciology, and oceanography—has both contributed to and been strongly altered by the new global tectonics.

As the geologic framework of Antarctica has become known, it has become apparent that the continent is composed of two quite distinct parts, East Antarctica and West Antarctica. Much of the basic picture of Antarctic geology was outlined by the early exploring expeditions of the Heroic Period, especially those of Scott, Shackleton, and Byrd, but broad and detailed geological knowledge of the continent has largely resulted from the work of all the Antarctic Treaty nations since the International Geophysical Year.

East Antarctica—the portion of the continent bounded by the Indian and South Atlantic Oceans and the Transantarctic Mountains—is a shield complex of Precambrian and early Paleozoic age. This shield area has been affected by a series of orogenies, culminating about 500 million years ago. Following extensive erosion, the shield was covered by relatively flat-lying continental and marine sediments of Paleozoic and early Mesozoic age. These younger rocks were, in turn, intruded during the Jurassic by thick igneous sills. An ice cap up to 5,000 m. thick blankets all of East Antarctica except the crest of the Transantarctic Mountains and a few exposed coastal areas.

West Antarctica—comprising the rest of the continent, which borders the Pacific ocean—is also largely ice-covered. The continental crust is thinner and may be discontinuous, with the suggestion of fragmentation in the interior and an island-arc structure along the Marie Byrd Land and Ellsworth Land Coasts. The Ellsworth Mountains, which contain the highest peaks in Antarctica, have a unique section, some 12,000 m. thick, of folded metasediments ranging in age from late Precambrian through highly fossiliferous marine Cambrian beds and up to continental Permian beds.

Recent work indicates that the coastal belt of West Antarctica is a zone of folded Mesozoic geosynclinal sediments that has been intruded by granitic rocks of Cretaceous age. Some mountain ranges in the coastal belt seem to be composed of older metamorphics incorporated into this orogenic zone as tectonic blocks. The island arcs that make up the Antarctic Peninsula and the Scotia Arc tie South America to Antarctica. The Peninsula is made up primarily of Mesozoic geosynclinal sediments, intruded by Cretaceous granitic rocks. There are a few areas of Tertiary sediments and volcanics, such as the plant-bearing rocks of King George Island and others of the South Shetland Islands.

The age relationships, tectonic trends, and seeming continuity with the Antarctic Peninsula, Scotia Arc, and ultimately with the southern Andes strongly suggests that the Circum-Pacific Mountain Belt is continuous through these portions of Antarctica and is probably connected, to the northwest, with New Zealand through the Balleny Islands and the Macquarie submarine ridge. Recent volcanic activity in Antarctica is limited to West Antarctica (the Balleny Islands, Mount Melbourne, Ross Island, Deception Island, and the Scotia Arc).

The Transantarctic Mountains stretch across the continent for nearly 4,000 km. from the Pacific coast in North Victoria Land to the Atlantic coast, south of Africa. Sub-ice topography and the structure of the mountains themselves suggest that they are a long and complex horst structure that was raised, at least in part, during the mid-Tertiary.

Geologic History and Mineral Resources

A number of specific geological problems have appeared during the scientific exploration of Antarctica. Some have been at least partially solved, while others are still to be investigated or even formulated. During a

1957 over-snow traverse from Ellsworth Station, for example, a series of ranges later named the Pensacola Mountains were discovered that are, in part, made up of nearly flat-lying basic igneous rocks. Detailed field work by the U.S. Geological Survey begun in this area in 1965-66 outlined a stratiform, mafic intrusive complex, called the Dufek intrusive, of post-Permian age in the northern Pensacola Mountains. Outcrop areas in the Dufek Massif and Forrestal Range indicate a single large intrusive body of over 8,000 km.^{2} and a known thickness of at least 6 km. Aeromagnetic data show a series of linear, high-amplitude, magnetic anomalies for 50 km. to the northeast and for an equal distance to the northwest, with extensions outside the surveyed area. Ford and Boyd, therefore, suggest that the maximum size of the intrusion may be several times that of the suggested minimum.

Although the Dufek intrusive is the only large-scale mafic complex now known in Antarctica, several occur in other parts of the world. Their economic significance as sources of valuable minerals, especially copper, chromium, platinum, and nickel, are roughly proportional to their extent and thickness. The Dufek is larger than any of the other mafic complexes of the world, except the Bushveld Complex of South Africa. Each such intrusive complex has been sufficiently different in its origin, chemistry, differentiation, and pattern of distribution of economic minerals that the discovery of a new example opens up a number of new avenues of basic and applied research. Most valuable mineral concentrations in basic igneous complexes have been found near their bases, but, unfortunately, the lower part of the Dufek, estimated by Arthur Ford to be 1,000 to 2,000 m. below the lowest outcrops, is not exposed. Further geological and geophysical work, followed by deep core drilling, will be the next steps in the exploration of the Dufek, if its scientific and economic potential are to be assessed.

The Emergence of Gondwanaland

The complex interrelationship of the southern continents has long intrigued earth scientists. As early as 1858, Eduard Suess proposed the name Gondwanaland for a single continent consisting of India, Madagascar, Africa, and South America. In 1888 he demonstrated that Australia should be included and in 1901 added the Falkland Islands and Antarctica Peninsula. Suess based his ideas on the similarity of geologic formations in all these land areas to the Gondwana series of rocks in India. This continent is supposed to have fragmented and the resulting land masses drifted to their present positions since the Cretaceous, about 150 million years ago.

Early attempts to correlate geologic strata between continents were successful. However, this age correlation had not been conclusive in regard to continental drift, as each of the fossil animals or plants found to be similar to those of other fragments of Gondwanaland could conceivably have been carried across wide deep oceans as spores or have migrated through the oceans in larvae or adult form. Firm evidence for the breakup and drift of Gondwanaland has been meager until the last decade. The idea of continental drift, after an initial period of acceptance, fell into disrepute. Interest in the theory in the United States remained dormant, as it was not possible for the proponents to present a feasible mechanism, with sufficient energy, to move the continents.

A major effort has been made by earth scientists working in and around Antarctica to find evidence of the relationship of Antarctica to the rest of Gondwanaland and thus to support the theory of continental drift. Within the last three years, research in geological and geophysical oceanography, much of it on board the U.S.N.S. *Eltanin* in the oceans around the Antarctic, has shown that the ocean floor is spreading from central rift zones. Ocean spreading, therefore, provided the mechanism by which continents might move apart, but positive evidence of continental drift was still lacking.

Critics of the theory pointed out that Antarctica should have been inhabited by the same land animals that lived in the other parts of Gondwanaland. None of these had been found, however, although there were parallel relationships in many species of plants, terrestrial invertebrates, and marine animals. Geologists have, therefore, long searched for evidence of a type of animal in Antarctica that could only have reached that continent by land.

One of the Truly Great Fossil Finds

Teams from Ohio State University have been carrying out geological investigations in the Transantarctic Mountains since the I.G.Y. During the southern summer of 1967-68 they were working in the region of the Beardmore Glacier measuring Triassic sediments that are approximately 220,000,000 years old. There they had found fossil plants and other evidence that the sediments were either deposited on land or along a shoreline. Members of the field party, led by Peter J. Barrett and including David H. Elliot, Ralph J. Baillie, and David P. Johnston, were carefully sampling a conglomerate that appeared to have been deposited in a stream channel. Among the pebbles and cobbles that made up the rock they discovered what to them seemed to be a piece of bone about 6 cm. long. Realizing that this would have extreme significance in the interpretation of the geologic history of Antarctica, they carefully recovered the bone and returned it to Ohio State University. Edwin H. Colbert, a vertebrate paleontologist

at the American Museum of Natural History in New York, was called upon to confirm the organic nature of the sample and, if possible, to identify it; and he agreed that it was bone and further identified it as a fragment of the jaw of an extinct fresh-water amphibian belonging to a group called the labyrinthodonts.

As a result of this discovery, a party of 16 scientists, with additional support personnel, returned to the same general area of the Transantarctic Mountains during the southern summer of 1969-70. The group included Dr. Colbert and other vertebrate paleontologists, invertebrate paleontologists, and specialists in the various aspects of the geology of the region. The choice of personnel and good planning resulted in the remarkable discovery by the party leader, David Elliot, during the first week in the field, of a bone-bed deposit containing a variety of Triassic vertebrate remains. These include disarticulated remains of labyrinthodonts and lystrosaurian reptiles.

In addition, they have also found the complete skeleton and plates of a fresh-water holostean fish in Jurassic beds. The holosteans were the dominant fish in fresh water at that time but are now represented only by the garfish of the Mississippi River and the bowfin of the northeastern United States.

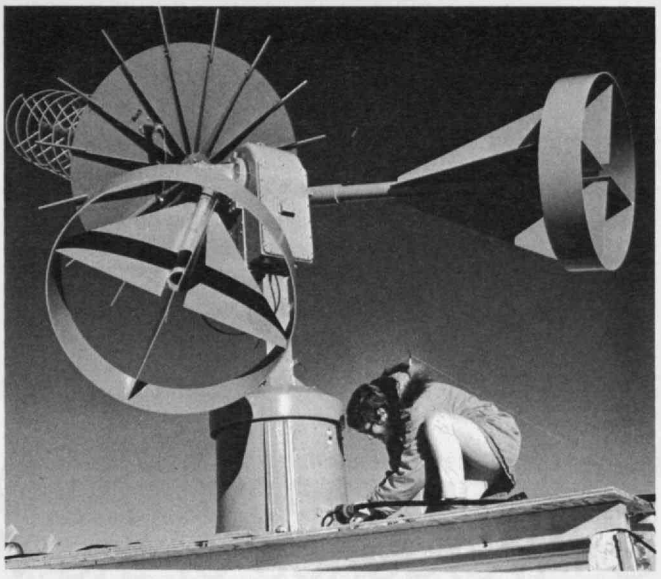
The discovery of the remains of labyrinthodonts, lystrosaurians, and other vertebrates in Antarctica would seem to fulfill the criterion that the critics of continental drift had established for accepting Antarctica as having once been a part of Gondwanaland. These vertebrates have been found in sedimentary beds of Triassic age in Africa, Madagascar, and Australia. They could not have reached Antarctica by sea, as they were not able to tolerate salt water. The labyrinthodonts, lystrosaurians, and the rest of this family must have migrated throughout Gondwanaland and into the portion that is now Antarctica by following the moist, tropical, swampy valleys and lowlands that were the environment in which they could survive.

Laurence M. Gould, Chief Scientist of the 1933 Byrd expedition to the Antarctic, and Grover Murray, President of Texas Technological University—who were in Antarctica on the 40th anniversary of Richard E. Byrd's first flight over the South Pole in 1929—visited the site of Dr. Colbert's work shortly after the lystrosaurus discovery. Dr. Gould telephoned the National Science Foundation that the two visitors "considered this not only the most important fossil ever found in Antarctica, but one of the truly great fossil finds of all time."

Glaciation and Continental Drift

Coincident with the discovery of fossil land animals in Antarctica, field investigations of the geologic structure of Antarctica, particularly in the area of the Marie Byrd Land Coast, now show that tectonic trends are of the same age and would line up with trends in South America and southern Africa if the continents were brought together.

It is also known from several studies that continental glaciation took place throughout Gondwanaland during



This helical antenna is used at Byrd Station (by Charles S. Ranney, Stanford University) to track the Alouette II satellite as it records the spatial distribution of electron and ion densities over Antarctica—notably the "whistler" signals which superimpose a pulse of electromagnetic energy upon the solar-related background. (Photo: N.S.F.)

Permo-Triassic time. Research carried out by John Crowell of the University of California and Lawrence Frakes of the University of New Mexico shows that the pattern of ice movement, the location of centers of accumulation, and the relationship between the glacier termini and the sea give the consistently logical pattern that the tectonic trends required. Crowell and Frakes placed each of the three continents in the relationship to each other that is supposed to have been their position in Gondwanaland before continental drift occurred.

The presence of glacial deposits of the same age over what is now most of the Southern Hemisphere and India in the Northern Hemisphere has long been a difficult fact to reconcile with any reasonable reconstruction of Permo-Triassic paleoclimate. But Crowell and Frakes showed that the reconstruction of the Gondwanaland continent brings the total area of the Permo-Triassic glaciation down to a size comparable to the great glaciations of the Pleistocene. This reconstruction of the distribution of glacial deposits in Gondwanaland does not prove that continental drift occurred, but, taken in conjunction with the recent fossil discoveries, it has further strengthened the theory of continental drift.

The determination of paleomagnetic directions in oriented samples of rocks of various ages from different parts of Antarctica also reveals the location of Antarctica in relation to the South Pole at different times in geologic history. Sufficient paleomagnetic data are now available to show that the continent has moved in relation to the South Pole in approximately the pattern that is indicated by the other evidence, pointing to the breakup and drift of Gondwanaland. These discoveries will be among the important keys to the interpretation of the geologic history, not only of Antarctica but of the entire world.

Oceanography: The Stormy Convergence of the World Ocean

Louis O. Quam
Acting Head, N.S.F. Polar Programs

The ocean surrounding Antarctica, sometimes referred to as the Antarctic Ocean, sometimes as the Southern Oceans, is in reality the southern parts of the Pacific, Atlantic, and Indian Oceans. From 50° S to the Antarctic coast near 70° S the ocean girdles the globe—restricted only slightly by the 650-m.-wide Drake Passage and the islands of the Scotia Arc between South America and the Antarctic Peninsula. Nowhere else in the world do the ocean waters merge and intermix—all Northern Hemisphere connections are by narrow straits only. As if to take advantage of this opportunity to mix the ocean waters, Nature stirs them by the violent winds of the "roaring forties" and the "screaming fifties."

These waters are also overturned in a vertical mixing. As the surface waters freeze along the Antarctic coasts, salt is separated out; as a result of the combination of low temperature and high salinity, the waters beneath the sea ice attain a high density. These waters sink and move northward and are recognizable as the Deep Bottom Water even in the Northern Hemisphere. Even the surface waters surrounding Antarctica, although low in salinity, are cold and dense as compared with the waters of tropical and temperate-zone origin in the three major oceans with which they merge.

Oceanographers recognize two frontal or boundary zones where these waters converge—the Antarctic Convergence and the Subtropical Convergence. The Polar Front, or Antarctic Convergence, lies about 50° to 60° S and completely surrounds Antarctica as a belt where the colder Antarctic Surface Water underrides the warmer waters along a sloping interface. Thus, south of the Polar Front three major water masses are identified: the cold Antarctic Surface Water; the cold, saline Antarctic Bottom Water; and between these an exceptionally thick, warmer water mass contributed by the Atlantic, Pacific, and Indian Oceans called the Circumpolar Deep Water.

The Circumpolar Deep Water upswells near the Antarctic coast, bringing heat to the surface water and to the hemisphere and supplying vast quantities of nutrient minerals. These nutrients support a rich phytoplankton growth which is the basis for the exceedingly rich zooplankton dominated by krill.

The general transport of the Antarctic water is easterly with a northward component of the Antarctic Surface Water and of the Bottom Water. Replacement of these losses is by the southward movement of the Circumpolar Deep Water. The volume transport of the Antarctic circumpolar current is very large. Estimates range from 45 to 90 x 10^6 cu.m./sec. by Ostapoff (1961) to 200 x 10^6 cu.m./sec. by Gordon (1967). These estimates were made on the geostropic (pressure-density balance) model, and their variance points to the need for direct observation of current velocity.

Gordon has used a core-layer method of studying the water masses of the Atlantic and east Pacific ports of the Antarctic Ocean, with core layers identified by extreme values—either maximum or minimum—of temperature, salinity, or oxygen. He concludes that "any theory attempting to explain the Antarctic water circulation must include a strong barotropic mode and the influence of bottom topography. A purely wind-driven model of the circumpolar current does not yield acceptable results without making questionable assumptions."

Topography and Geologic Structure

The floor of the Antarctic Ocean is also being explored by the U.S.N.S. *Eltanin,* which carries satellite navigation equipment, a precision-depth recorder, a seismic profiler, a proton-precession magnetometer, and a gravimeter. It has been determined that a mid-oceanic ridge surrounds the continent except for the sector of the South Atlantic between 30° E and 90° W in the East Pacific. At these meridians the mid-oceanic ridge apparently becomes the Mid-Indian Ridge and the East Pacific Rise, respectively.

The structure in the sector lacking a pronounced ridge

is extremely complicated and apparently reflects extensive latitudinal (east-west) movement in the western sector and meridional (north-south) movement in the Indian Ocean sector. The eastward curving tips of South America and the Antarctic Peninsula and the arcuate form of the Scotia Islands are thus surface expressions of the east-west structure, and the fault zones bordering East Africa are expressions of the north-south movement.

The Antarctic mid-oceanic ridge has the characteristics of a spreading ridge—transform faults and linear magnetic anomalies consisting of alternate normal and reverse magnetized strips. In fact, the data collected by Pitman and Heirtzler aboard the *Eltanin* in 1965 on four crossings of the Pacific-Antarctic Ridge has become the classic example of bilateral symmetry of magnetic anomaly. When these magnetic-anomaly profiles were related to the magnetic-reversal time scale of Cox, Doell, and Dalrymple, a spreading rate of 4.5 cm. per year was indicated. In subsequent publications, Heirtzler and his associates have showed that the linear magnetic pattern, which is symmetric about the crest of the Pacific-Antarctic Ridge, can be traced from the edge of the New Zealand continental shelf at 175° E to 90° W and that the same pattern extends into the North Pacific.

Le Pichon and Dr. Heirtzler also show that the pattern in the Indian Ocean is very complex. The ridge axis is clearly recognized south of Australia to 70° E and 20° S and from there northwestward to the Gulf of Aden. A second, highly disrupted branch extends southwestward around the tip of Africa, where it may extend into the Mid-Atlantic Ridge. Vine has suggested that this southwest branch of the Mid-Indian Ridge is inactive, since the axis of the ridge appears to lack the younger rock series. Dr. Heirtzler believes this ridge was active during the early breakup of Gondwanaland in Permian and lower Mesozoic time; but during a later period of complex movement in the Indian Ocean, the northward movement of the Indian block was accompanied by a series of fracture zones in this southwestern branch. This complex and geologically interesting area was scheduled to be studied during the current 1970 *Eltanin* cruises.

Other investigators have applied paleomagnetic dating techniques to long sediment cores from the Antarctic region. Paleontological stratigraphy for the region, based on Radiolaria, had already been established by Hayes; he and Opdyke observed that faunal boundaries tend to correlate with magnetic polarity change. Goodell and Watkins sought to test Uffen's theory that the loss of magnetic shielding during the zero-dipole field, which may occur in a geomagnetic polarity reversal, might lead to increased rates of genetic mutation owing to excessive cosmic radiation. They looked for other possible variables such as a change in type or rate of sediment accumulation which might correlate with faunal extinction. They found no correlation of these, though they found that sediment type did change at or near some faunal boundaries; and they concluded that, since faunal extinction is not directly due to the increased radiation from dipole collapse during polarity change, then its cause must lie in other factors.

Recently, however, James Kennett and Norman Watkins have found sedimentary evidence, in deep-sea cores from south and southeast of New Zealand, that volcanic activity in that area took place or increased in intensity at the time of magnetic reversals. The most abundant evidence of volcanism is at the Brunhes-Matuyama boundary (0.7 million years) and the Matuyama-Gauss boundary (2.4 million years); others, less well defined, seem to be related to shorter-duration geomagnetic events. Kennett and Watkins suggest that this is evidence for a relationship of the upper mantle and geomagnetic activity.

Whatever the causal relations between them, both magnetic reversals and fossil characteristics are powerful tools for deciphering earth history. Research on sediment cores is especially rewarding in areas of high latitude because faunal changes are likely to be more sharply defined in areas of severe climate, and because, in the case of magnetic reversals, the high magnetic-dip angle simplifies the problem of orientation. It is not necessary to know the horizontal orientation (azimuth) of the core to detect magnetic reversals; one needs only to know which end of the core is the top.

An important conclusion from the study of sediment changes in relation to magnetic reversals is that the first evidence of glacial detritus occurred about four million years ago. Significantly, scientists studying the moraines of the Victoria Land area have discovered interbedded lava which indicates a similar age for the oldest glaciation of that part of Antarctica.

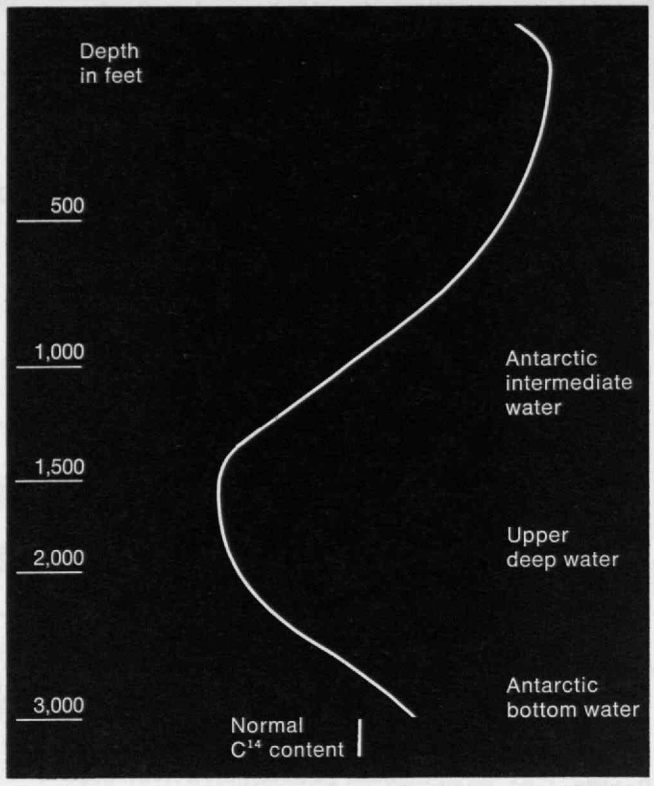
Glaciology and Climate

Glaciology, the study of snow and ice in all its forms and processes, is an obvious field of investigation in Antarctica, whose ice sheet contains 30 million km.^{3} of ice, 90 per cent of all the ice on earth. The challenging problems related to this great ice sheet are overwhelming, despite the advances in our knowledge over the last decade.

The present balance of the ice sheet, whether it is growing or shrinking, is still unanswered to a satisfactory degree. Because world sea level is known from tide gauge measurements to be rising at the rate of 2½ in. per century during the first half of the twentieth century, it was thought that the Antarctic ice sheet, like most other glaciers of the world, is decreasing. Yet those who have studied the problem most extensively conclude that for the whole continent the mass balance probably has a gain of about 4.5 g./cm.^{2} per year. Uncertainties in the determination of mass balance or a reversal of balance in the last decade may explain this seeming inconsistency.

It has been estimated that more than 99 per cent of the area of the ice sheet is at present a region of positive balance in which snow accumulation exceeds ablation. Only around the coast and in a few inland areas subject to very strong winds does ablation exceed snow accumulation. Almost all of the ice loss is by calving of ice shelves and glacial tongues into the ocean.

Sampling of sea water from the Antarctic in the area south of Australia has revealed that significant amounts of carbon-14 released from nuclear bomb testing have been taken up by the ocean at high southern latitudes. The Upper Deep Water corresponds to a water mass originating in the North Atlantic before the atomic era; the higher concentrations are found in water masses which have a fairly recent origin at the surface.



The interior of the ice sheet contains a record of its own history. Annual layers of accumulation can be detected by differences in density, hardness, and grain size of summer and winter layers. Many investigators have correlated the thickness of annual layers of snow in pits and bore holes with measurement of surface accumulation on stakes emplanted in the snow.

The Antarctic Research Program has supported the development of a unique combination of equipment and techniques for drilling deep holes through several thousand feet of glacier ice and for the recovery of ice cores from these holes. The original development work was done at Camp Century by the U.S. Army's Cold Regions Research and Engineering Laboratory in Greenland. This effort resulted in the penetration of the Greenland ice cap, which is 1,360 m. thick at that point, and the recovery of an almost complete core section. The equipment was then moved to Byrd Station, Antarctica, where C.R.R.E.L. completed a similar drill hole through more than 2,600 m. of ice to the base of the Antarctic ice cap.

During the same general period a method had been found for distinguishing between summer and winter layers on the basis of the ratio of stable and radioactive isotopes. Simply stated, the ratios of these isotopes in snow precipitated in the Arctic or Antarctic represent the temperature history of the air masses in which the water vapor traveled from the source regions to the polar areas. These ratios would represent differences in temperature between the warmer regions and the polar regions for the period immediately preceding precipitation. Winter snow in the polar areas, therefore, has a higher proportion of 0^{18} than snow precipitated during the summer. The ratios present in samples covering several winter-summer cycles indicate average world climate for that period. The determination of the oxygen and hydrogen isotopic ratios for ice brought up from increasing depths in the ice cap are, thus, climatic indicators for the increasingly distant past.

Among the first laboratory research projects completed on the ice cores from the Greenland and Antarctic holes has been the determination of the ratios of the oxygen isotopes 0^{16} and 0^{18}, and the determination of the hydrogen isotopes H^1 and deuterium from the Byrd hole. The determinations on the Greenland material were done by Samuel Epstein of California Institute of Technology and by W. Dansgaard of Denmark, and the analysis of the Byrd hole material by Epstein and Robert Sharp of the California Institute of Technology. In Greenland, Epstein's early work showed close agreement with Benson's snow stratigraphy, giving confidence to both methods of determining annual accumulation. In Antarctica, oxygen or hydrogen isotope methods have been checked against stake measurements in many localities. In general, the isotope methods give results consistent with stake measurements at sites where the annual positive balance is high (20 g./cm. or more), but elsewhere the isotope ratio values tend to be greater than stake measurements.

Epstein and Sharp in 1963 concluded from a study of a 288-m. core from a hole at Byrd Station that the mean annual temperature at that location has increased 2° to 4° C. in the last 200 years.

Other historic events recorded in the ice layers include volcanic eruptions (local and worldwide), periods of meteor showers, the change in atmospheric gases since the industrial revolution, the increased practice of crop dusting, the slow and then rapid increase in lead as a result of the vast quantities put into the atmosphere by the burning of tetraethyl lead in automobile gasoline, and, most recently, the fallout from atomic weapons tests. Recognition of such events as the "Castle" weapons test (1954) also serve as checkpoints for the other ice-dating techniques.

Before these analyses were available, it had been conservatively estimated that ice near the base of these ice caps might be 10,000 to 20,000 years old. However, as the results of the determinations of the isotopic ratios were plotted for the Arctic and Antarctic ice caps, it became apparent that in the lower portions of both drill holes long periods of much colder climates are

represented, preceded by periods of climate comparable to the present.

By extrapolation of the annual snow stratigraphy of the last few decades, which is preserved near the surface, it was obvious that these early relatively warmer and subsequent colder periods represented the pre-Wisconsin interglacial and Wisconsin glacial periods, and that the ice from the lower portions of both the Arctic and Antarctic holes is in the range of 100,000 to 200,000 years old. This opens up tremendous potentialities for the direct study of atmospheric composition, climate, rate of infall of extraterrestrial material, volcanism, precipitation, and ice cap dynamics for a much longer period into the geologic past than had been anticipated when the project was initiated.

With further direct dating of the ice at various levels in the two holes, it will also be possible to determine whether the climates of the two polar regions vary in or out of phase with each other during the last glacial-interglacial-glacial cycle. No other recent discoveries have so great a potential for determining the multitude of long-range cyclic factors that are so significant in our environment.

Glacial Geology in North and South

Another record of the history of the ice sheet is derived from glacial geology, the sequence of erosion and deposition of rock material in areas now ice-free. Extensive areas of Victoria Land on the east side of the Ross Sea known as the "dry valleys" are now largely free of snow and ice. Through the work of Nichols, Péwé, Denton, and others, a fascinating story of advances and recession of the ice in this area has been revealed.

In Victoria Land the Transantarctic Mountains form a barrier to the huge ice sheet of East Antarctica. In the past, glacial tongues from this ice sheet overrode the ranges and formed the deep glacial-carved valleys such as Taylor Valley and Wright Valley. Later the ice receded from at least the lower parts of these valleys, and today they are ice-free except for small glacier tongues from the ice sheet at the valley heads.

To the east the Ross Ice Shelf covers most of the Ross Sea. Denton and Armstrong have worked out the sequence of ice fluctuations in these valleys and established their chronology by potassium-argon dating of volcanic lavas between successive glacial deposits and carbon-14 dating of algae found in younger glacial deposits. Their data indicate that the ice sheet of East Antarctica, attaining a size much larger than its present mass, shaped the valleys prior to 4 million years ago and has since undergone several changes in surface level. Five distinct glacial invasions of the Taylor and Wright Valleys are recognizable.

In the lower part of these valleys, ice from the Ross Ice Shelf has in the same way expanded periodically, sending tongues of ice *up* the valleys. Radiocarbon dating of the two youngest ice advances from the ice sheet and from the Ross Ice Shelf shows that these two sources of ice have apparently alternated in extending ice tongues into the dry valleys. Denton states that "the present geometric relation of Taylor Glacier to radiocarbon-dated Ross I and II deposits, as well as the interrelation of Ross and Taylor drift sheets, indicates that the ice to the west of Taylor and Wright Valleys is now at its maximum surface level since before Ross Glaciation II." He correlates Ross Glaciation II with an Early Wisconsin or an Illinoian Glacial Stage of the Northern Hemisphere. That is, the Ross Ice Shelf appears to have increased in harmony with Northern Hemisphere glacial advances, but the East Antarctic Ice Sheet in the Victoria Land area appears to have fluctuated out of phase with the glacial stages of the Northern Hemisphere.

Suggested Readings

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Dr. Louis O. Quam has been associated with the Office of Naval Research since 1950 and Director of its Earth Sciences Division since 1959—a post from which he is on leave to be Acting Head of the National Science Foundation's Office of Polar Programs. He studied at the University of Colorado and Clark University and has served on the faculties of the Universities of Colorado and of Virginia. Ray R. Heer, Jr., was trained in physics and mathematics at the Universities of Louisville and Illinois and was associated with the Air Force Office of Scientific Research for nine years before assuming his present N.S.F. post. A research specialist and Associate Professor of Botany at the Air University from 1951 to 1957, Dr. Llano—a graduate of Cornell, Columbia, and Washington Universities—was associated with the U.S. National Committee for the International Geophysical Year and with Antarctic programs of the National Research Council before joining N.S.F. in 1961. Mort D. Turner worked in the field of economic geology for the California Division of Mines and Geology and the Commonwealth of Puerto Rico before joining the U.S. Antarctic Research Program in 1959; he holds degrees from the University of California (Berkeley).

The destruction of the earth, as performed by technology under the direction of the human species, is not a satisfying prospect; the concept of stability provides a means to look for other visions

Jeffrey Ingram
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Formerly Southwest Representative of the Sierra Club

Can We Make the Future Worth Surviving In ?

This earth is the only home we have.

Is it not strange, then, that we treat the planet as if we were vandals passing through, conquerors laying waste the existing, less vigorous, order? Such a question is inescapable as the smog of battle chokes our battered cities, as our rivers and lakes run with the planet's dead juices, as our land lies shocked by our weapons, littered with their fragments.

Surely man is the maker of tools, devices to shape the world to be more beneficent for man. And yet, how—if it could—would the prairie have regarded the plowshare; or Amchitka "atoms for peace?" How pleased could a sentient mountain range be with the highway engineer's transit; or a salt marsh with the dredge and bulldozer?

We are now coming to know a little; we are beginning to know what a euphemism the word "tool" is, because our reshaping of the earth is starting to affect us strongly and unpleasantly. Too soon, we may fully understand how a mosquito feels about that tool of public health, DDT.

Man has faced unpleasant situations before, but never so widely and obviously of his own making. Never has the issue so clearly been, not whether we can develop "tools" to control a threatening environment, but whether we can control the use of our "weapons," by which we weaken and abuse our environment. We have used our weapons to take the world apart and put it back together so that it works better—from our point of view. We did not anticipate all the ways the new structure would operate, however, and the many pollutions to which we are now suddenly sensitive indicate that we must rethink how we use our weaponry so that it works to preserve the future, not simply to make the present more comfortable. Our war on the earth has so overwhelmed it that we must devise a new strategy.

Past and Future Strategies

The most certainly disastrous strategy of the several alternatives from which we may choose is continuing the quasi-exponential extrapolation of what we have always done. In *Traveler's Rest* David Masson describes a war being fought with increasingly sophisticated weapons near the edge of time. H, the protagonist—he is no hero—thinks it strange that no matter how elegant the weapon thrown at the Enemy on time's other side, the return is equally elegant, equally destructive. The story ends as H, and the slow reader, are beginning to suspect that the Enemy, H's own forces, and the sole user of the marvelous destructive devices are one and the same. Of course, H's commander entertains no such speculations, and the war intensifies.

H's position is not unlike man's with respect to what we are doing to our environment, our life support system. There is only one flaw in the analogy: H's stuff came back unchanged; the effects of our attacks are attenuated. When we release a nuclear bomb in the atmosphere, the result is not that the atmosphere drops a bomb on one of our cities—but that fallout travels across the world, and electromagnetic effects even further, temporally as well as geographically.

One farm editor has been fooled by this attenuation, insisting that no human being has yet died of DDT poisoning. The editor is not alone. We are too much concerned with increasing agricultural production, and continue to work at it, without pausing to decide whether the battle we are conducting on a "useful" plant's "enemies" may not lead to a Pyrrhic defeat for us. In spite of the history of the lamprey in the Great Lakes or of detergents in streams, we continue to deploy our forces without much forethought of how the natural world will handle and return our deadly inventions.

Most fundamentally, we have never really wondered whether the strategy of increase may not have become a bad choice.

Those who accept increase as the way of the future anticipate, even with joy, the doubling of the world's population by 2000. They call brightly at the same time for doubling the living standard of the world. With determination, they note that this will call for more than a quadrupling of food, potash, pesticides, private research organizations, electric power, financial investments, oil production, government agencies, etc.

Man's experience might seem to support this faith in increase. Los Angeles had this faith. When its population was nearing 300,000, about the turn of the century, the city fathers knew that the local water supply would not handle a larger number. Since increase was thought

desirable, and was called inevitable, the city went first to the east side of the Sierra Nevada, then later to the Colorado River, and is now working on an aqueduct from the Sierra's western slope. A scheme to put a California hose in the Columbia River was recently thwarted, but—given Los Angeles' commitment to increase—the frustration may well be only momentary.

Los Angeles wanted to increase. It did, and is now the common example of slurbs and smog. But the cost is not just the dirty local air and the price of an aqueduct system, for water importation is in part paid for by the federal government and is thus a national cost. This will be even more true of the Sunday-supplement continental water transportation schemes, soon to begin their legislative journeys.

Thus it is fair to say that the issue posed by Los Angeles' increasing population is posed for the nation; it is the issue posed by doubling of the whole world's people: Given the already extensive damage we have done to the human environment, will we be able to survive if we invest ever greater quantities of the earth's resources and human time simply to provide for more people?

Or even if we might survive, should we go on doubling?

The Opportunity of Stability

The questions are not rhetorical; doubling is not inevitable, although we often pretend it is by treating projections like predictions and then making them come true. Continued increase, because it is the reigning attitude of man toward his existence, presents this clear directive for our behavior: Use anything for your benefit as it comes to hand, where benefit is made measurable and comparable by some quantative term, the most abused being the dollar.

Stability is an alternative, involving a reconsideration of how we should behave in our only home. For instance: Is it not possible that an industry of hand-crafted, lovingly built, nonpolluting, long-lasting automobiles would do as much for the prosperity of a fixed population as planned obsolescence does for our present condition of continuous increase? Is it not conceivable that the farming of trees on already-cut-over land would supply the needs of a fixed consumption rate of wood, just as cutting more and more virgin timber is deemed necessary to meet our increasing demand? Is it possible that the amount of copper now mined and being mined is enough for many centuries if stability of population and consumption is the standard, in the same way that more and more new sources and new extraction and production methods, are now providing for our ever-growing numbers?

Obviously not, some people will say. Stability implies poverty; only an increasing population with increasing demands can power real prosperity. The electric power industry, for instance, points to an increase in demand far above population projections. Unfortunately, this claim, like others of its type, is self-fulfilling. One West Coast utility recently advertised nationally for more industries to come to its area, stating that power would be available for the increased activity. The same company complains simultaneously that it must be allowed to build the plants it has designed in order to meet "demand." Manipulation of the earth may be necessary to some degree if any of us is to survive at all, but exploitation to serve an increase in demand that was sought by the exploiter himself seems unreasonable. The irrationality is made more obvious by noting that the new power plants involve ever more extensive destruction of the very attractions for which people are enticed to come.

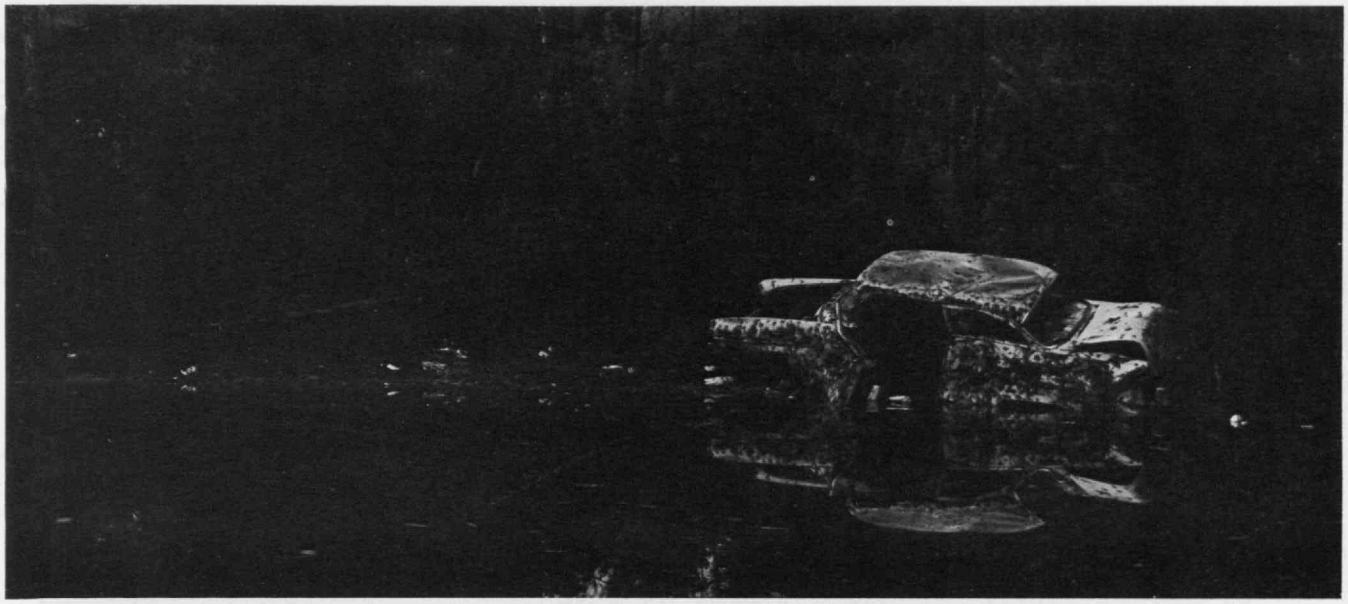
The Questions of Stability

The irrationality of continuous doubling does not make the strategy of stability an obvious one, however. Stability seems defective as a framework for economic and social activity because our whole economic standard and experience suggest that a fixed base of resources must lead even for a fixed population to increasing impoverishment. Can the concept of a stable society be developed so that it can include a prosperous economy but not a ravenous one? What are the limits on a resource's longevity and utility?

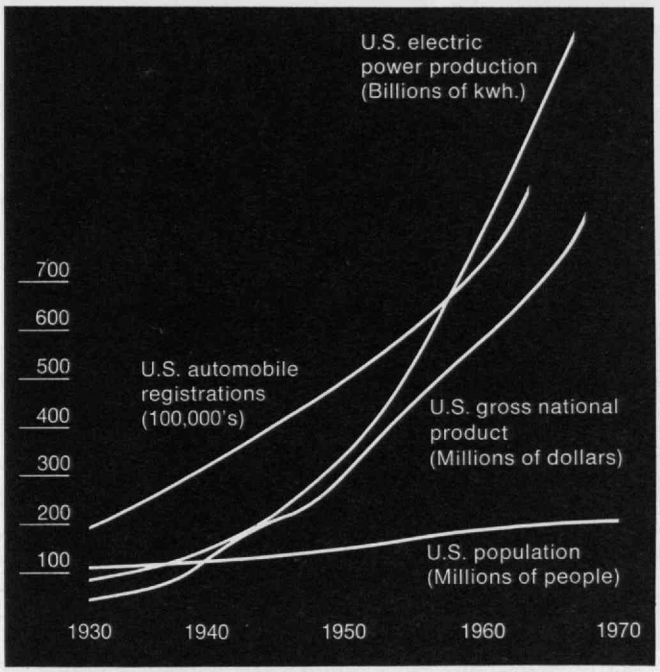
Again, for instance: Designers of the City of the Future, engineers and planners like Athelstan Spilhaus, are depending on reusable building materials. But will a photographer have reusable film? Long-lived cars could be taken apart for their materials, but will we have enough paint to redo them often enough to provide variety? (Stability should, after all, be a chance for excitement more sane than watching the baby counter at the Census Bureau. Stability ought not to be dull.)

We may be able to recycle water or dispense with those of its uses that stem from its present low cost, but how can we cope with a steady use of wild rivers that seems bound to degrade the recreational experience? We can set aside a certain amount of land for crops—no subdividing, please—but can we keep up food productivity without an accumulation of residues from water, fertilizers, and pesticides that will eventually render it useless? We can mine our available copper and then fix a copper budget, but can we recover the metal efficiently enough to be able to switch from one use to another, as need shifts? Will we be stimulated enough to care about new uses, new rewards?

Must there be some permanent depletion of materials,



Growth is the fundamental economic strategy of the U.S. While population has nearly doubled during the past four decades, the U.S. consumption of energy, transportation, and the nation's gross national product have grown exponentially. Predicting an environmental crisis, the author proposes that "the United States, as the premier technological civilization, lead the way in choosing stability, the alternative that can provide man with both longevity and quality."



even if the large percentage is recoverable and re-usable? Have we applied our ingenuity as discoverers and inventors to the goal of reclaiming what we have used? Have we tried to take into account that the earth is finite, and sought to devise ways to close our resource systems, even the more possible ones, involving water, metals, food, wood, and fiber? Have we thought about what to do with systems that do not even seem cyclic, like synthetic materials production, outdoor recreation, and energy generation?

These are questions for technical imagination and competence; they will be answered only if technologists work on them. Of course, as technologists, we cannot put the house in order if the owners, including us, really do wish to tear it apart; but our real opportunity is to go ahead and show how the house could be a sound structure for longer, so we can all better decide.

Each of the multitude of problems in defining a stable society can be dealt with as an item, its technical parts separated and worked out; then each must be put together with the others and efforts made to predict how each will work as part of the whole. And we will still need in the end to decide on the system's desirability.

Stability's Challenges for Technologists

To start at the beginning, for example, we are improving rapidly in our understanding of the technology of birth control. Unfortunately, we still treat reproduction largely as a matter of biological capability, forgetting that family size is culturally induced, that more effective technology must be accompanied by changes which will render its use more acceptable. (In the case of birth control, this must mean changes making the elderly less dependent on their offspring.) Pope Paul's Encyclical is so tragic not because he will deter those who know about and use contraception, but because he has missed for the Church an opportunity to help educate its people about changes in the balance of death and birth.

The quest for population stability would be strengthened by research to show how it could come about and what its effects on our way of living would be. We might start with a study that assumed some fixed population for the United States achievable in 1990. For this fixed population we would calculate our needs, using a minimum of extrapolation from the present standard of living, emphasizing the adequacy of present achievements for most of our people and the necessity of raising the poor to that level. This exercise could be done in different ways, and this variety would suggest the range of our choices within the context of a stable population and consumption.

Assuming fixed consumption, we can study different combinations of needed resources, estimate how nearly adequate are present supplies, and seek equivalent materials for those that will be in short supply or not re-usable. Integrating these supply-and-demand studies will require research on new technologies that would enable us to re-use materials or trade one resource off against another. A fixed budget of iron, for example, might be manipulated to appear in a variety of forms, but only if the methods of conversion are known.

Development of such technologies is more than a standard task of engineering and scientific innovation, for the concept of stability means nothing unless each part of the system, each technological apparatus, each weapon, is chosen for its contribution to environmental longevity. We will gain little from pollution-free cities if to achieve them we must cover all remaining open space with solar heat collectors.

Government agencies now use a ratio of dollar benefits to costs to determine whether or not a construction project is economically feasible. From this viewpoint, the costs of stability may appear high. But survival may be cheap at any price; the costs of that benefit must not be calculated in dollars but in the years added to or substracted from our environment's ability to support us.

Stability's Opportunity at M.I.T.

Work that can contribute to such a study is being done by many people in many places. But the thinking is still diffuse and dispersed, for it is being done in response to the host of specific and urgent problems that arise from our multiple activities. The broad, effective study of the economics of stability requires contributions from every technology—not just to suggest new ways of doing things but to evaluate the potential, and later the actual, effects of following out a new way. These contributions would be less than useful if they were done independently, for the overall patterns of technological and social change—not just the collection of new weapons—must be understood and presented to the public for choice.

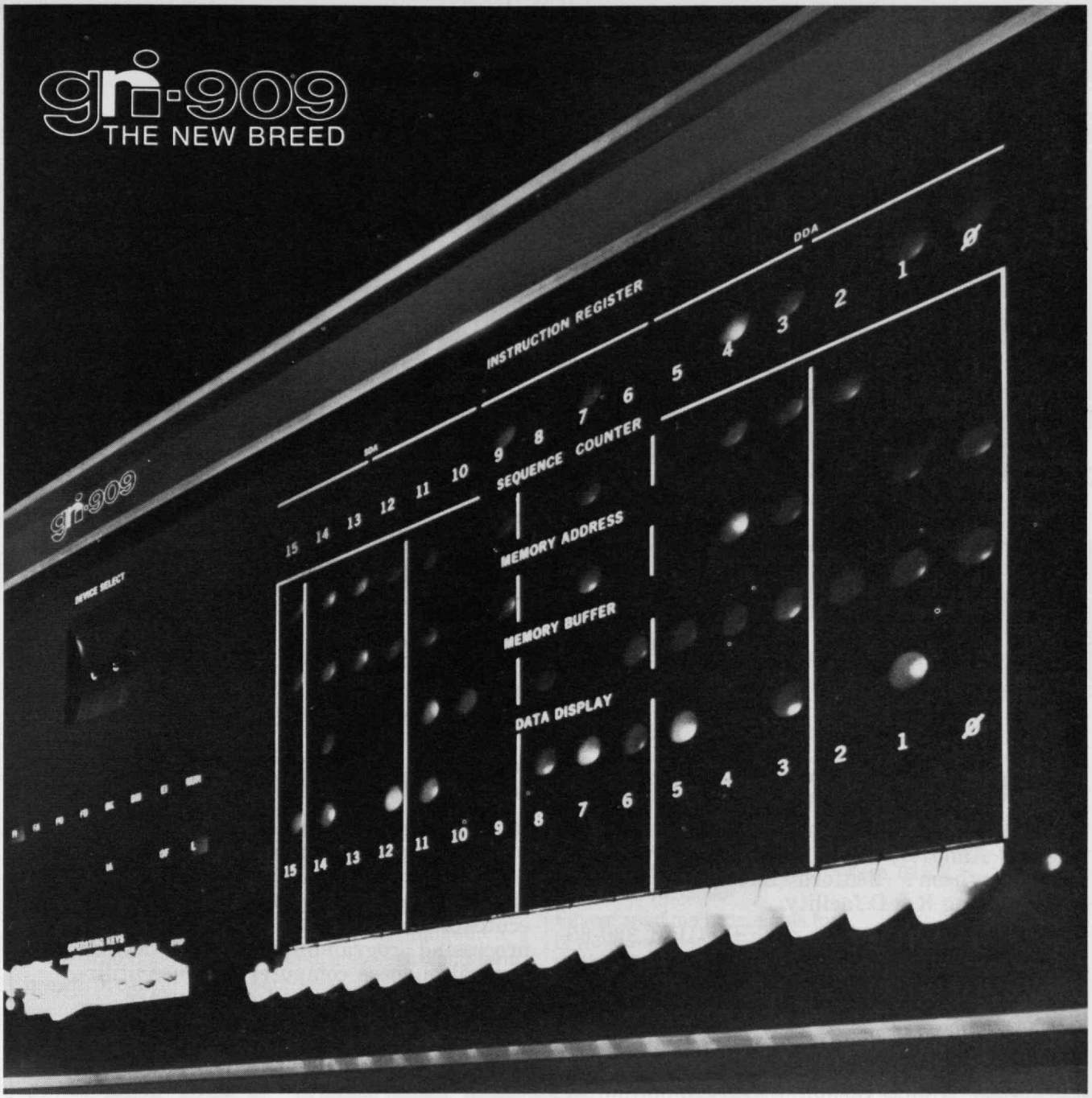
Indeed, an effective study of the stable society requires a tremendous concentration and integration of disciplines. The brilliance, consistency, and value of the technical developments will be quite lost if they are simply dispersed in our present society. (We increase the number of our automobiles in such a way as to swallow up the benefits of pollution control devices, for example.)

Only by studying the potential parts of the stable society in an integrated framework can this choice be made real. This is a true multidisciplinary problem—for scientists and engineers, for economists and political scientists, for psychologists, for architects and planners, and indeed for humanists. There is probably not even an order of magnitude difference between urban problems and environmental ones, since the latter are made so intense by the existence of urban concentrations. The problems of making cities livable for a long time are now the problems of controlling environmental deterioration.

I have argued that ensuring a healthy environment for the near, and the far, future requires that the United States work toward a condition of population and consumption stability. I am now urging that the U.S. immediately proceed to studies that are necessary if we are to know what stability means in detail, and what we will have to do to achieve it. I am certain we will find that the alternative of stability provides a coordinating viewpoint for both environmental and urban studies, a viewpoint that will not only lead to solutions for specific problems, but also provide a criterion to judge what areas of research are of prime importance. Put another way, working within such a framework tells us what questions to ask.

The world is driving toward a crisis of pressure on the environment. More and more people want more and more things that require more and more resources, the production and consumption of which is causing more and more degradation of the air, the waters, the earth. If the crisis is to be avoided, then the United States, as the premier technological civilization, must lead the way in choosing stability, the alternative that can provide man with both longevity and quality. Could M.I.T., as the premier technological university in this civilization, lead the leader?

Jeffrey Ingram returned to M.I.T. this fall after several years with the Sierra Club as its Southwest Representative, stationed in Albuquerque, N. M., where he helped to develop the Club's in opposition to construction of a dam in the Grand Canyon. He graduated from M.I.T. in mathematics and political science in 1958 and later studied at Columbia University and the University of New Mexico.



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Trend of Affairs

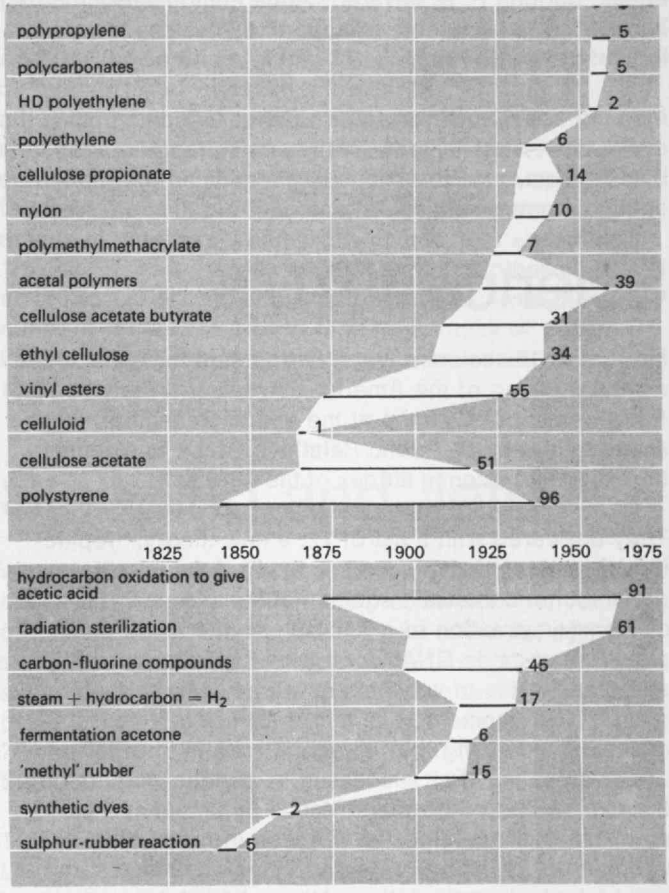
On the Other Hand, Not So Fast

It is well known that the time lag between the scientific discovery of a new principle and its practical application is growing shorter and shorter. This is illustrated in the upper part of the diagram, showing the dates of discovery and exploitation for a number of chemical advances. It is taken from data provided by F. H. Newth in the British *Swann Report on Scientific Manpower,* published in 1968.

An alternative view is illustrated by the lower section of the diagram, in which successive commercial achievements are seen to be based on progressively older and older research. These data, and the juxtaposition of the two pictures, are provided by John Langrish of the University of Manchester (*Science Journal,* Vol. 5A, No. 6, pp. 81-84).

Mr. Langrish questions two common assumptions: that "basic research provides most of the original discoveries from which all other progress flows"; and that "the whole of science must be supported, in order to allow for the discovery of new scientific information whose use cannot be anticipated until it is discovered." He writes: "The alternative possibility—that scientific discoveries do not really contribute to economic advance except in exceptional circumstances—has not been seriously considered." Out of the belief that there is some connection has grown the habit of measuring time lags between discovery and use (a habit which he traces back to 1933) and the conviction that the time lags are shortening, which "has obvious attractions for those who believe that more money should be spent on science."

The U.K.'s Council for Science Policy is financing a study, by the University of Manchester's Department of Liberal Studies in Science, of about 80 technical innovations which have earned their exploiters the coveted Queen's Award to Industry. The study, says Mr. Langrish, "has shown that many industrial innovations are part of a continuing process of change within a particular industry, and the connection of this change with science is rather obscure. It sometimes seems that science and technology are two quite separate activities which occasionally come into contact with each other."



Although the time from scientific discovery to technological exploitation is generally said to be narrowing (top), J. Langrish has assembled data showing almost as convincingly that it is widening. He doubts the importance of the alleged connection between science and technology.

Mr. Langrish asks why the belief that "innovation is always applied science" persists, and he suggests a possible answer: that this belief is based on a relationship which did indeed hold at one time. Britain's Department of Scientific and Industrial Research was founded in 1917, when the country was experiencing a wartime shortage of certain materials which German industry had developed on the basis of scientific research. Considering organic chemistry and industrial dyestuffs, Mr. Langrish observes that "the relationship between discoveries in the new science and the development of the new dyes was much closer than it is today." Today's new methods of dyeing are rooted in the chemistry of the nineteenth century, and the role of university chemistry departments has been "not the making of a discovery subsequently used by industry

but the training of people who then went and worked in industry"—a finding to which Mr. Langrish returns in his conclusions.

Having cast doubts on accepted ideas as to the relationship between science and industrial progress, Mr. Langrish searches for real justifications for pure science expenditure. One is the cultural argument: "Just as a civilized country should be able to subsidize grand opera or an Olympic team, so it should finance science." When science expenditures become disproportionately large to be buttressed by this reasoning, he suggests, science proponents should move into the attack, quoting F. R. Jevons: "Apparently useless knowledge is preferable to apparently useless technological hardware."

Industry does, however, need science, Mr. Langrish concludes—"but for different reasons than it needed it in the past. . . . What industry needs is not new science, but new scientists."

Science 1970's

More than 100 science writers, in Boston to report the annual meeting of the American Association for the Advancement of Science at the end of December, were asked by the M.I.T. Public Relations Office to forecast the "biggest" science stories of the 1970's.

They answered with a list of 12: a new theory, "replacing general relativity, to explain the final stages of gravitational collapse"; solution of the physical basis of memory; creation of a natural enzyme using completely man-made DNA; control of hurricanes, rain, and other forms of weather; development of a fusion reactor; development of vaccines for some types of cancer; overcoming the rejection problem in organ transplants; the first successes in genetic engineering; the exploration of Mars and Venus by unmanned instrument packages; partial success in controlling environmental pollution; progress in population control; and biological manipulation of the unborn fetus.

When the science writers arrived for a party in their honor at M.I.T., they were told by Philip Morrison, Professor of Physics, that their list was too ambitious; science, said Professor Morrison, won't go that fast. But Professor Morrison made a forecast of his own: "The basic biochemical developments that shaped life on this planet took place before anything that we have ever seen in any museum," he said. The mystery of how it all started remains unsolved. But within five years scientists will be able to "couple the success of microbiology into paleontology" and begin to see what preceded what we now know as the first life to have appeared on earth.

David Perlman, Science Editor of the *San Francisco Chronicle,* held a different view: "The really big science stories will sneak up on us unawares; we won't know it's happening until it's all over," he said. "The really meaningful—and hopeful—things aren't on the list, because they will be progress, not answers."

The biggest science story of the 1970's may even be a nonstory. Victor F. Weisskopf, Head of the M.I.T. Department of Physics, proposed that, as people gradually become more interested in science for the sake of what it does than for what it is, there may be a migration out of the laboratory. Perhaps, he said, only those "who are really interested in new ideas, in science as a way to understand and express nature" will remain.

"A good thing," he said.

The Significance of Sound and Fury

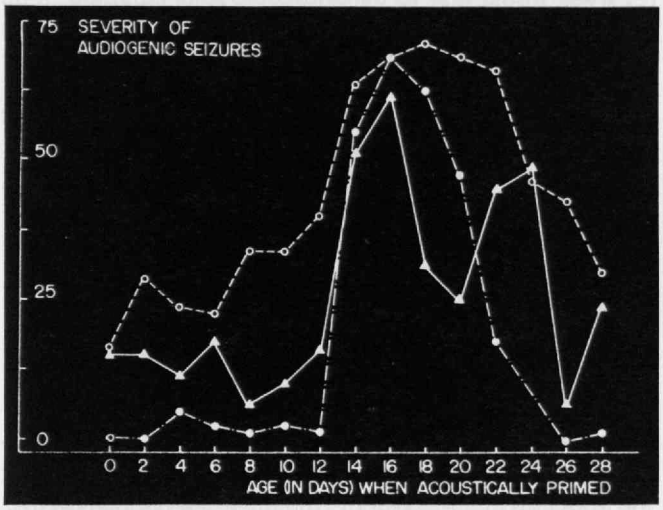
"There seems to be little doubt that noise pollution is a health hazard. . . . It is our hope that further research and study will help initiate a worldwide movement for effective control of noise pollution." Thus did Dr. Samuel Rosen, consultant to the Mount Sinai School of Medicine and the Eye and Ear Infirmary, New York, initiate a two-and-a-half-day symposium on the physiological effects of audible sound, at this winter's annual meeting of the American Academy for the Advancement of Science.

The keen-eared Mabaan of the Sudan, who live in virtual silence and never suffer from high blood pressure or coronary disease (unless they move to Khartoum), recover very quickly from the shock of a loud noise. "The healthier an organism is, the better it can resist injury from any cause, including noise," said Dr. Rosen. But "we now have millions with heart disease, high blood pressure, and emotional illness who need protection from the additional stresses of noise."

Physiological reactions to sound are many and varied. Dr. Mary F. Lockett, of the University of Western Australia, reported that if rats are exposed to a frequency of 150 cycles at an intensity of 100 db. (the loudness of a subway train 20 ft. away, roughly) they hardly seem to notice it as a disturbance, and yet it causes the release of the hormone oxytocin from the pituitary, which in turn stimulates the excretion of salt and water from the kidney. One function of oxytocin is to cause the expulsion of milk from the mammary gland during suckling. At the same volume, a 20-kilocycle sound (inaudible to normal humans) causes the animals to "freeze into the alert position." Again, kidney excretion is stimulated, but this time through the agency of the adrenal glands.

When a juvenile mouse, of a strain not ordinarily susceptible to acoustically induced seizures, hears an electric bell at 103 db. for 30 seconds, it appears "very nonreactive." If it hears the same sound a few days later, it often undergoes "convulsions which terminate in death." This phenomenon, described by Kenneth R. Henry and Robert E. Bowman of the University of Wisconsin's Regional Primate Research Center, is described by the term *priming.* It is highly reproducible. There is an age at which priming is most effective. It seems to work by lowering the seizure threshold in

The severity of seizures induced in 28-day-old mice by an electric bell (ringing for 30 seconds at 103 db.) depends on the age at which the mice were previously "primed" by exposure to the same noise. The suggestion is that this priming affects some nerve structure which is at a critical stage of development at age 16 days. The three curves are for different genetic varieties of mice.



some nerve structure which is at that age undergoing a particularly sensitive phase of development.

It has also been observed in primates, but with light rather than sound. The researchers suggest that a species may exhibit the priming-for-seizure phenomenon in relation to whichever senses it most relies on. "Although our research has not used human subjects, the presence of musicogenic seizures in man raises the possibility that he might show a similar phenomenon"—that is, acoustic priming. It may be that further study will show "an increase of sound-produced convulsions in people who spent their infancy near sources of intense sound."

A general discussion of the effects of noise and other stresses was provided by Dr. William F. Geber of the Medical College of Georgia. He suggested that "the following sequence of events occurs, more or less, with the application of any stress agent no matter what its physical or chemical or chronological dimensions may be: stress received—higher brain centers activated—lower centers and hormonal systems activated—cardiovascular response—combined effects of vascular and hormonal response—alteration of exchange mechanisms at the repair or division pathways—induction of changes in nucleic acid synthesis—and, finally, the production of temporary or permanent alteration in the most vulnerable system(s) or tissue(s) at the time of application of the stress."

The most vulnerable tissues will be those that are differentiating, so "stress applied to the pregnant organism during critical periods of organogenesis represents the most needed area of intensive investigation." Dr. Geber recommended a long-range study of noise stress, not only in a wide range of animals but also in various human personality types.

Other speakers, however, were reassuring. Dr. Jack M. Heinemann of the T.R.W. Life Sciences Center, Falls Church, Va., reported studies at the White Sands Missile Range, N.M., which "conclusively demonstrate that sonic booms of higher intensity than are normally produced by supersonic aircraft have no effect upon the percentage of poultry eggs which hatch."

And Dr. James Bond, of the U.S. Department of Agriculture's Animal Husbandry Research Division, reviewed a number of field experiments, mostly by his own Division, on the effect of aircraft noises and sonic booms on a variety of animals. Neither kind of noise appeared to affect the milk production of cows. The behavioral effects of booms on cattle, race horses, and sheep were "minimal." Swine exposed to aircraft and other noise at 100 to 120 db. at various stages of their lives did not suffer in respect of growth rate, food intake or utilization, or reproduction, and their ears, adrenals, and thyroids seemed undamaged.

Sleeping and Jets

When a big commercial jet flies over your home at less than 2,000 ft., grandmother will probably (55 per cent of the time) be wakened. But the rest of the family will sleep through it—93 per cent of the time. If it's a supersonic jet making a normal overflight (causing a "boom" of up to 1.25 lbs./sq. ft.), 70 per cent of sleepers in the 70-year-old range will be wakened, only 2 per cent of the rest.

Two Stanford Research Institute scientists, Jerome S. Lukas, Senior Research Psychologist, and Karl D. Kryter, Director of the Sensory Sciences Research Center, reported these results to the American Association for the Advancement of Science in Boston this winter. They added a word of warning: the groups of sleepers they tested were small, and so their results "must be considered with some caution at this time."

Children are least bothered by aircraft noise; no sonic boom up to 2½ lbs./sq.ft. wakened seven- and eight-year-olds, and only when the fly-over noise reached 113 PNdb. (perceived-noise decibels) did it wake them. Adults are more sensitive: 5 per cent were wakened by sonic booms of 2.5 lb./sq.ft., 10 per cent of them by 107 PNdb. fly-over noise. The grandparents complained so much of fatigue that they were subjected to a smaller number of tests—and the loudest sound ranges were never used.

How much you were bothered depended somewhat on how deep was your sleep. And in some cases the noise was obviously disturbing, though not disturbing enough to completely wake a deep sleeper.

How Many People Is Enough?

Growing world population, and the realization that our planet is finite, suggest the question: Is there an optimum level of population? This question was the topic for what was perhaps the most popular gathering of all, arranged by J. Fred Singer, Deputy Assistant Secretary in the Department of the Interior, at the annual meeting of the American Association for the Advancement of Science.

Preston Cloud, a Professor of Geology at the University of California, Santa Barbara, began the two-day debate by saying that we are "deluged with evidence that, for current conditions, a world population of 3.5 billion already exceeds the optimum, while the more than 200 million inhabitants of the United States are also too many for its level of consumption and aspirations."

He quoted the National Academy of Sciences' Committee on Resources and Man to the effect that world food supplies might be increased to nine times the present amount, "provided that sources of protein were essentially restricted to plants, and to seafood mostly from a position lower in the marine food chain than is now customarily harvested—and provided metal resources and mineral fertilizers are equal to the task, and that agricultural land is not unduly preempted for other purposes." This implies that the world could ultimately support 30 billion people "at a level of chronic malnutrition for the great majority"—a figure that would be reached by 2075 at present growth rates. But, Professor Cloud judged, the number that "*might* eventually be supported over the long term at a moderate level of affluence" is only 7 billion—which will be reached around the turn of the century.

Accepting "the often-expressed goal of 'development' for all now underdeveloped countries," this population, living in a comparable fashion to modern Americans, would need to keep in circulation more than 60 billion tons of iron, about a billion tons of lead, 700 million tons of zinc, and more than 50 million tons of tin—between 200 and 400 times the present world annual production of these commodities, and much more lead, zinc, and tin than the presently inferred reserves.

"Rising expectations among the deprived peoples of the earth that they too may share the affluent life are doomed to bitter disappointment, without population control. . ." Professor Cloud deduced; and even Americans "will be confronted with the hard choice of foregoing some of their affluence or continuing to import, at increasing rates, the raw materials on which underdeveloped countries might base their own industrial growth."

Alvin Weinburg, Director of the Oak Ridge National Laboratory, affirmed his belief that, given enough energy, materials problems could be solved. The present per capita energy consumption in the U.S. is 10 kw. (thermal); for the world as a whole, 1 kw(t). All necessities could be provided by 15-20 kw(t). At this rate, our coal reserves would last 10 billion people only 25 years—but the energy available from breeder reactors is limited only by the disposal of heat and radioactive wastes. At a world population of 20 billion, the total world heat balance would not be affected, and local imbalances would be minimized by siting the reactors in "nuclear parks" on the seashores. Life with such a population would be unpleasant perhaps, but not impossible.

...and Can We Stop There?

Barry Commoner, Director of the Center for the Biology of Natural Systems, Washington University, considered the question in the sense of "the optimum population for ability to survive the approaching environmental crisis." In view of the threat to the stability of the world's ecosystems posed by rising demands for food, he said, twice the present world population will be about the maximum possible. Demographic studies show that birth rates fall only when an observable fall in mortality rates has induced a sense of security (because each individual attempts to insure that some of his sons will survive to care for him in his old age, should he himself survive). It would take a generation, at best, for such a sense of security to take hold, by which time the world population will have doubled. "If we start now, and we're lucky, we can just break the thing."

But it will also require redressing disparities in the distribution of food. For example, the Peruvian anchovy catch, which is sufficient to supply the total protein deficiency of Latin America, is being imported by the U.S. to feed livestock and poultry, whose price it reduces at the cost of an extremely inefficient use of the protein it contains.

Lincoln H. Day, Associate Professor of Public Health and Sociology at Yale University, began with some answers that have been given in other times and places:

"The best limit of the population of a state is the largest number which suffices for the purposes of life and can be taken in at a single view." (Aristotle)

"After a degree of density has been attained, sufficient

to allow the principal benefits of combination of labour, all further increase tends in itself to mischief. . . ." (John Stuart Mill)

"Families by Tikopia custom are made corresponding to orchards in the woods. If children are produced in plenty, then they go and steal because their orchards are few. So families in our land are not made large. . ." (a Polynesian, via anthropologist Raymond Firth).

Professor Day pointed out the impossibility of correlating changes in population with changes in the quality of life, and noted that people in any case grow used to quality changes. Except from a narrow economic standpoint, we can decide on an optimum size of population only within very broad limits. But something can be said about the demographic characteristics of this population nevertheless, for it will presumably be stable, unlike our own; and presumably mortality will be low.

Setting life expectation at birth at 71 years, the median age would be 37, as against the present U.S. figure of 27. People over 70 would constitute 10.1 per cent, compared with 6.2 per cent now. But the total proportion in the "dependent" age groups, counting these as below 18 and above 64, would be less, not more, than in the U.S. today—40 per cent, against 45 per cent.

This distribution would not, as has often been suggested, be undesirable—"a society of greybeards in wheelchairs"—said Professor Day. "The current preference for youth and rapid change may itself be a reflection of our own period of unrepressed numerical and technological expansion. The assumption that rapid change is invariably a desirable condition of human life may well yield to a greater appreciation of the value of stability and continuity with the past."

The Moral Choices of Tomorrow's Genetics

Any advance in genetics dramatic enough to reach the newspapers seems to set off a ripple of interest in the dangers of "genetic manipulation." During the annual meeting of the American Association for the Advancement of Science, Dr. Bernard D. Davis of the Harvard Medical School attempted to identify and evaluate these dangers.

He identified the major possibilities for genetic engineering as: the alteration or selection of germ cells, the alteration of somatic (nongerm) cells, and the synthesis of cells. The last of these possibilities is too far off to be of concern now, he said; and the alteration of somatic cells presents no moral problems. One might, that is, conceivably be able to treat individuals for hereditary physical diseases carried by a single gene, but molecular biology seems to offer no way of doctoring any of the traits characteristic of human nature, such as intelligence and temperament: these are polygenic, and "show a broad, continuous distribution of values for any variable that can be quantitated."

Various ways of altering or selecting germ cells merit consideration. The alteration of the genetic content of a germ cell by chemical or viral means, or by exposure to selected genetic material, might be possible in the not too distant future. But it is not clear how this could be made into a practical technique for a given purpose.

A more serious possibility is the taking of nuclear material from the body cells of selected individuals and transplanting it into egg cells, from which large numbers of identical individuals could be obtained. "If possible, it seems inevitable for agriculture; the danger of extension to man would then be serious."

A third way of altering germ cells is to fuse the nuclei of different species. Interspecific hybrid cells are now living in tissue culture, but "whether such mixtures of chromosomes would also be compatible with differentiation into a viable organism seems doubtful." Disturbing as the prospect of man-made half-men undoubtedly is, Professor Davis does not regard it as a real possibility for the near future.

The most practical approach to genetic engineering remains what it always has been, the selection of heritable characteristics before breeding, and the transference of this method from farm animals and plants to human beings has always been technically possible. Negative selection—that is, the attempt to reduce the transmission of genetic diseases—is currently practiced: genetic counselling, and the testing of fetal cells for recognizable diseases which would justify abortion.

Professor Davis said that although suggestions for positive eugenic programs have in the past, as he put it, fallen on sterile ground, the idea of deliberate selection is likely to be viewed increasingly favorably. For one thing, proposals that procreation should be legally limited in the interests of world population control raise the question, *whose* procreation? Second, advances in our understanding of genetic influences on behavior may provide eugenics with a theoretical basis which has hitherto been lacking. "As our technology grows more complex and our planet more crowded, the effective adaptation of the species, and perhaps even its survival, may require genetic as well as cultural measures to promote more cooperative social behavior and greater ability to cope with complexity."

The Scientists Debate Science in Space . . .

America's space program is coming of age. Its multiple successes suddenly present a bewildering array of alternatives, and to many at the annual meeting of the American Association for the Advancement of Science in Boston this winter the problem seemed to be less how-to-do than what-to-choose.

The basis for choice is changing, too. Gordon J. F. MacDonald, Vice-Chancellor for Research and Graduate Affairs at the University of California, Santa Barbara, pointed out that in the past "we have justified the space program on grounds in which science had a minor part." Now, he said, science must have a larger part; we must ourselves set some priorities—"determine what are the real scientific and technological values in carrying forward a program of space exploration."

Eugene M. Shoemaker, Chairman of the Division of Geology at the California Institute of Technology, recalled that John Wesley Powell began his exploration of the Colorado River by traveling its 1,000-mile length in three months, making only a "fragmentary scientific effort." But two years later, having learned how to deal with the problems of living on and along the river, Powell returned to devote five field seasons to a scientific study of geological history as revealed in this great canyon.

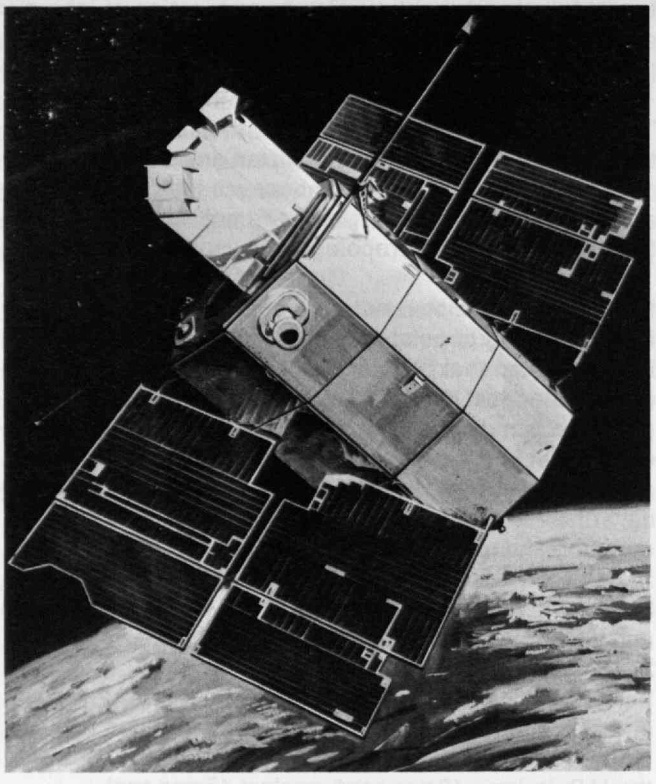
The U.S. Space Program, said Dr. Shoemaker, must follow Powell's course. Having solved the technical problems, we must now concentrate on the scientific goals. Frank Press, Head of M.I.T.'s Department of Earth and Planetary Sciences, agreed: "History will judge the American space program as a stunt" if we do not carry out the full lunar program to which present activities are a "very elementary preparation," he declared.

. . . Mars vs. Moon . . .

Harold C. Urey, Professor-at-Large at the University of California, San Diego, saw a larger scientific issue. "The most interesting single question we are asking in the space program," he said, "is whether or not there may be life on Mars"; and if there is it will be "the most important finding in the history of science." Yet he agreed that—except for this—scientists are in for a disappointment if they expect to learn much about the history of the solar system from Mars and Venus. The surface of our moon, far less altered by erosion than the planets, may be unique. "Right on our doorstep," said Dr. Urey, "is the best laboratory for determining the age of the solar system."

Professor MacDonald agreed, insisting that "we should be asking 'Why?' " when people say a Mars landing is "inevitable."

S. Fred Singer, Deputy Assistant Secretary of the Interior, made a different suggestion: Mars' two satellites, Phobos and Deimos, may represent a more attractive space objective than their parent planet. Unlike our moon, they have probably never been heated, melted, or metamorphosed. If they are captured asteroids, Phobos and Deimos would represent our first opportunity to examine such bodies. If they formed as original satellites of Mars, they they are probably our first opportunity to sample planetesimal material.



According to Nicholas S. Sinder of Grumman Aerospace, the Orbiting Astronomical Observatory is an example of how space-based astronomy can be done well without manned satellites.

For all these reasons, he told the A.A.A.S., these Martian satellites "represent one of the most exciting opportunities for planetary research and particularly for manned exploration. The technical problems involved in landing are much simpler than those on Mars and the rewards in terms of fundamental science may be even greater," he said.

. . . and Man vs. Machine

The man-in-space argument was introduced at the A.A.A.S. meeting when astronaut Edwin E. Aldrin, Jr., the Lunar Module pilot on Apollo 11, told an overflow audience that "we have not yet found a way to build an unmanned scientific vehicle that can use a hammer on a stuck nuclear fuel element."

Arguments on the other side came from two industrial representatives. H. L. Wolbers of McDonnell Douglas

Astronautics Co. pointed out that manned spacecraft inevitably leave behind an orbit littered with waste fluids, exhausted air, leaked gases, and exhaust from reaction control systems. These contaminants, traveling with a spacecraft, can affect its communications and fog its optical systems; and the smaller the spacecraft the fewer the contaminants.

Nicholas S. Sinder of Grumman Aerospace Corp. pointed to the success of the Orbiting Astronomical Observatory spacecraft series to argue that successful space astronomy requires no manned stations—only a further investment in sophisticated unmanned technology. A large unmanned orbiting telescope, which has now been included in N.A.S.A.'s future program, requires no fundamentally new space science, he said. But to use it effectively will require transmitting information from spacecraft to ground at the rate of 1 to 100 million bits/sec., "and we are now having trouble with 50,000 bits/sec."

Meet Ivan, Engineer

Ivan Stepanovich Smirnov is a (mythical) typical Russian engineer. He is the invention of Herbert Sherman, a member of the M.I.T. Lincoln Laboratory staff, whose avocation is the study of Russian professional life. Mr. Sherman uses Ivan's case to dramatize the professional and personal expectations of today's Russian engineering graduate in the December issue of I.E.E.E.'s *Spectrum* magazine; he was one of 12 representatives of I.E.E.E. chosen to attend the 1969 convention of the Popov Society, Russia's counterpart of the U.S. Institute of Electrical and Electronics Engineers.

When he completes his five-year undergraduate engineering course, Ivan knows that his salary on his first job will be 120 rubles per month. (One ruble = $1.11, but simple conversions are inaccurate "because the disposable income differs so widely between the systems as a result of tax differences and state-provided or subsidized services," writes Mr. Sherman.) After a six-month probationary period, Ivan's job security is very high; the engineer's union in Russia makes his dismissal "virtually impossible." He can expect a 10 per cent raise after three years. If he passes a foreign language examination or learns a new computer language, he can expect a 10-ruble salary increase. If he is credited with a new patent, he gets at least 60 rubles, more if it is considered critical.

As he progresses in his career, depending upon his own success and the productivity of the group with which he works, Ivan may receive occasional bonuses of 30 per cent or more of annual salary, and these may come to be "an important addition to his income," writes Mr. Sherman.

If Ivan goes back to school for graduate work, he will probably work on contract research while taking advanced courses. Here his earnings will be up to 170 rubles per month. When and if he completes his requirements for the Candidat degree (he has a 25 per cent chance of survival), Ivan "enters a new social stratum," writes Mr. Sherman; his salary will be at least 300 rubles per month. It will be more if he becomes a group leader, if he writes important books (200 rubles per 16-page signature), or if he achieves an appointment as professor (500 rubles) or director of an institute (600 rubles). His salary can be supplemented by consulting assignments.

To be designated an Academician of the Academy of Sciences represents "the very pinnacle" of success for a Russian scientist, a Corresponding Member of the Academy the next highest honor. These carry supplementary stipends of 500 or 250 rubles per month.

Thus the range of salaries between top and bottom of the Russian engineering profession is about 10:1, says Mr. Sherman—compared with 5:1 in the U.S.

Ivan's budget is very different from that of his U.S. counterpart. In the first place, Ivan's wife almost surely works, too, except for the first two or three years after the births of their children. Their medical expenses are insignificant; the state takes care of most of them—and of school and university tuition for himself and his children, and of his "social security."

Ivan's housing—typically assigned to him in a bloc of apartments reserved to his company—is inexpensive (10 to 12 rubles a month) and small (9 square meters per family member). Or he can purchase an apartment for about 100 rubles per square meter.

Ivan pays 6 rubles for a monthly pass on public transportation; a new car costs him at least 3,000 rubles, a lightweight motorcycle 450 rubles. State-controlled clothing and food stores are inexpensive; if Ivan wants better quality or more variety he can buy imported goods at very high prices (200 rubles for a hand-tailored suit, for example). Ivan can buy a 5-cu.-ft. refrigerator for about 300 rubles, a radio-phonograph for 150 rubles, a black-and-white television for about 250 rubles, and a washing machine for less than 100.

But there are compensations. Books are inexpensive and plentiful, records cost less than 1 ruble each, and the best seat to the ballet is 2½ rubles. And Ivan pays only 15 per cent of his income in direct taxes; there are no local real estate taxes.

On Thinking Ahead

Between one and three million years ago, a land bridge, the Isthmus of Panama, rose to join the two Americas. Prior to the advent of the isthmus, Atlantic and Pacific waters met at this point across some hundreds of miles, sharing in common their flora and fauna. Now man is thinking of reopening a portion of this seaway, and he seems to have learned the necessity of taking into account *in advance* the ecological implications of his actions.

Among the reasons for worrying about possible ecological effects of a sea-level canal at Panama is the knowl-

edge that the appearance of a land bridge between the Americas brought disaster upon the land fauna of the Southern Hemisphere, among which there were no carnivores; the South American species simply had no defense against the meat-eating invaders from the north. The Northern Hemisphere, too, had its vegetarians but, accustomed as they were to living among their carnivorous brothers, they survived at a much higher rate. The upshot was nothing less than a collapse in the diversity of South American land fauna. A similar concern for Panamanian sea flora and fauna was the focus of one seminar at the recent A.A.A.S. meeting in Boston.

Detailed studies, such as the one now being conducted by the Atlantic-Pacific Interoceanic Canal Study Commission, are already producing the hard facts on which sound decisions about the effects of a sea-level canal can be made. Although conclusive overall data is not yet in, initial indications lead Dr. Howard Fell, Curator of Invertebrate Zoology, Harvard University, to statements of cautious optimism. The opening of a sea-level canal might be ecologically beneficial: a return, in fact, to a more normal state of affairs—more normal, that is, when seen over geological time.

The results of transplanting flora are unknown. But although there have been no controlled studies of the effects of transplanting sea grasses—and the flora at the Panamanian Isthmus are poorly known—their general functions are so productive, Professor H. J. Humm, University of South Florida, pointed out, that an "invasion" would be hard to see as anything short of beneficial. For fauna, the crucial factor in the ecological question may be the rate of evolution of different species. Among the slow-evolving species, such as echinoderms which have continued to evolve on either side of the Isthmus along similar paths in "geminite pairs," there is virtual certainty that no ecological damage could result. For sea creatures with a faster rate of evolution, however, the answers are still in doubt.

Perhaps more important than the specific answer on a sea-level Panama canal is this indication that at long last, when tampering with nature, man is learning to close the barn door before the horse is stolen.

The Third Age of Technology

The world is now on the threshold of the third age of technology, says Charles S. Draper, Emeritus Professor of Aeronautics and Astronautics at M.I.T. who retired this month after over 30 years' leadership of the laboratory which now bears his name.

The first age of technology was agricultural; its result was to transform farming so that a few men could produce food for many. The second age of technology had to do with inanimate objects. "Our preoccupation with inanimate objects has been so successful," Dr. Draper told an M.I.T. seminar this winter, that goods and information have suddenly become available to nearly everybody.

Now we must consider the *whole* problem, by "learning how to fit all this technology together into a system that works," said Dr. Draper. "The future is going to belong to people who put everything together—the easy and the hard—who will give up the assumption of the constant physical environment, producing conditions on earth which all people can accept. We can no longer work on technology by ourselves. We have to come to terms with the rest of the human race. I have come to believe that what used to be the central theme of our engineering education is now recreation. The hard work is coming."

Jerome C. Hunsaker, the founder of M.I.T.'s Department of Aeronautical Engineering 40 years ago, objected: "You've given us a history of artifacts, but no lesson on the history of behavior."

Dr. Draper admitted that evolution of the organism is a slow process. "But technology through which man can change the environment works very fast," he said.

Science Fiction Dead?

As genius is the mother of invention, so fiction may be the mother of fact. This intriguing possibility was one of many thrown out for consideration when scientists and science fiction writers gathered in Boston at the annual meeting of the American Association for the Advancement of Science. Buck Rogers' feats and gadgets of past decades certainly have their real counterparts today, and they are not isolated instances. The works of Jules Verne—a clerk in the French patent office during his writing career—have long been recognized for their prophetic content.

But what of the future? Is there a future for technologically oriented science fiction or has today's technology made such fiction obsolete simply by out-performing it? Harvard's B. F. Skinner, scientist and science fiction writer, believes that advances in technology and the physical sciences have preempted much traditional science fiction subject matter. There is no longer much entertainment value in stories of a superhuman with the ability to see into the far reaches of the universe, or conversely into the innermost secrets of matter, when the radio telescope and the electron microscope have given to ordinary men the ability to do both.

We can travel in space; we can reach the planets; we can induce the existence of elementary life forms in test tubes. Even the popular myth of mind expansion has its counterpart—the electronic computer. The very actuality of these gadgets and the capabilities they lend us generate excitement more intense than can fiction.

But the twentieth century has opened a broad new vista —fiction in the behavioral sciences, said Dr. Skinner, who is himself the author of such a work, *Walden II*. The future may bring drastic rearrangement of societal structures, and it may be that the science fiction writer, through the exercise of his art and access to a large popular market, will be an influential partner in that restructuring.

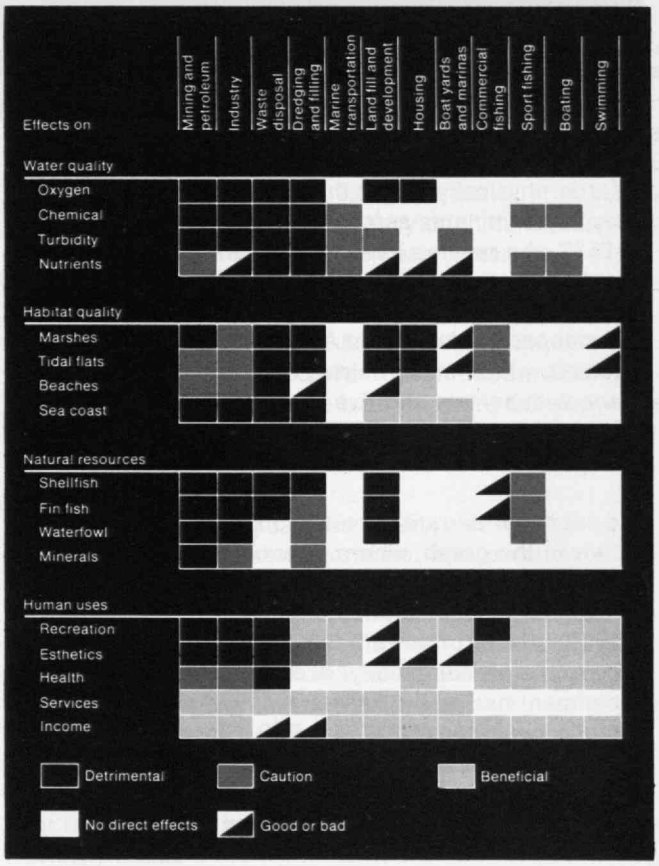
From Ecology to Engineering Choices

It is sometimes alleged that, while ecologists say a great deal about the environment which they think should be conserved, they do not often provide operational guidelines for the choice of engineering systems. When this allegation was made at the annual meeting of the American Association for the Advancement of Science, it was opposed by Bostwick E. Ketchum, Associate Director of the Woods Hole Oceanographic Institution, in a paper on the management of estuaries.

For any environmentally damaging substance or activity, he said, it is possible to decide, first, what was the problem which called it into being; second, what are its benefits, as a solution; third, what are the hidden costs of this solution; and fourth, what are the alternative solutions. For aquatic effluents from domestic sewage systems, this sequence can be summarized by the table shown. If the "hidden costs" are given the value which they assume in the long-term picture, said Dr. Ketchum, the recycling of domestic sewage proves to be far more attractive than the present solution or than the improved treatment methods currently under consideration, which will still result in the injection of large quantities of effective fertilizer into otherwise useful water.

As an example of the kind of statement that can be made in relation to estuary management, Dr. Ketchum showed the graph reproduced here. The various activities for which an estuary can be used are "scored" according as they affect the estuary's qualities and populations. Going one step further, a similar diagram can be generated showing, for each activity, which other activities are compatible with it, which may be compatible but damaging to the environment, and so on. Asked whether such an approach could be applied in a quantitative fashion to a particular estuary, Dr. Ketchum replied that it could, but cautioned against considering only immediate economic factors. "If you put dollar values on oysters and oil, the oil wins. But the problems are more fundamental than this."

Problem: Aquatic disposal of domestic sewage
Benefits
Untreated wastes
Lowest cost
Dispersion and transport away from source
Treated wastes
Reduction of organic material and smell
Reduction or elimination of sludge banks
Easier dispersion and transport
Hidden costs
Increases water purification requirements
Water unsuitable for bathing and recreation
Large areas closed for shellfishing
Decreased land values
Eutrophication (overfertilization) of natural waters results in:
Elimination of desirable species
Growth of obnoxious algae
Development of anoxic conditions
Alternatives
Improved treatment, including removal of minerals
Greater dilution (e.g. ocean disposal)
Recycling—balanced and controlled fertilization for aquaculture, forest culture or agriculture
"Dry" waste disposal methods



Any measure which can be criticized on ecological grounds, says Dr. Bostwick E. Ketchum, must have come into being as the solution to some problem. The original problem, the benefits of this solution, its hidden costs, and the alternative solutions, can be viewed together as a basis for a rational decision. The table shows one example: the aquatic disposal of domestic sewage.

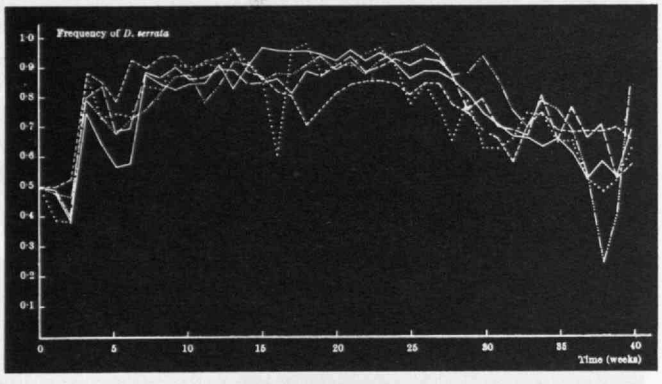
What is known about the effects of the various activities which may be carried on in an estuary can conveniently be summarized in a chart such as this. The next step is to discover which activities are compatible.

Fruit Flies Can Peacefully Coexist

"Two species cannot coexist in the same territory indefinitely if they compete for a resource available in short supply which is essential for their survival." This is one formulation of the venerable principle of competitive exclusion, an ecological principle which is of great theoretical value if true, but concerning the meaning and truth of which there is, in the words of Francisco J. Ayala, a "long-standing polemic."

Ayala is a researcher at Rockefeller University, New York, who has now demonstrated the principle to be false in experiments with two competing species of the fruit fly *Drosophila* (*Nature*, Vol. 224, pp. 1076-1079).

Relative numbers of two species of fruit fly competing for the same resources, in five separate mixed populations. After about ten weeks, a stable proportion was reached; a change in temperature around week 23 caused a shift away from this initial compromise towards new one.



He chose the species *serrata* and *pseudoobscura.* The latter is physically larger than the former, and at 19°C. it rapidly eliminates *serrata* in a competitive situation. At 25°C. the reverse happens: *serrata* eliminates *pseudoobscura.* Dr. Ayala tried breeding them in competition at 23.5 ± 0.5°C. He used two different strains of *pseudoobscura,* known as *AR* and *CH,* and ran six populations in which the *AR* strain competed for food and space with *serrata* and five in which *CH* did the same. Each population started with 300 adults of each of the two species.

The result for *serrata* versus *pseudoobscura CH* is shown in the graph, where "frequency" means proportion of the total population. After about 10 weeks of adjustment, the species adopted a stable compromise, heavily in favor of *serrata* but with *CH* showing no tendency to die off completely. Around the 23rd week the experiment had to be transferred, writes Ayala, to another incubator at 23° ± 0.5°C. Since lower temperatures favor *pseudoobscura,* the shift in balance that occurred is in the expected direction, but again "the two species seem to be in equilibrium."

Commenting on this coexistence, Dr. Ayala refers to his previous work on the species, indicating that *serrata* has the edge in the competition for food during the larval stage, but *pseudoobscura* adults seem better fitted to compete for space; and there is some evidence, he says, that for both, fitness to compete varies inversely with relative frequency. Perhaps number two tries harder.

Paying for Electric Power

Matthew Boulton's 200-year-old sales pitch—"I sell here, sir, what all the world desires to have: power"—has still not been greatly refined. But as the demand for power continues its inexorable ascent (*see chart*), some urgency begins to attach to two related questions: How much power do we really desire, and what are we prepared to pay for it? R. T. Jaske of the Battelle Memorial Institute's Pacific Northwest Laboratory in Richland, Washington, considers that it is time for a new public policy on power, to "create new standards of value based on the use of thrift in resource usage rather than conspicuous consumption."

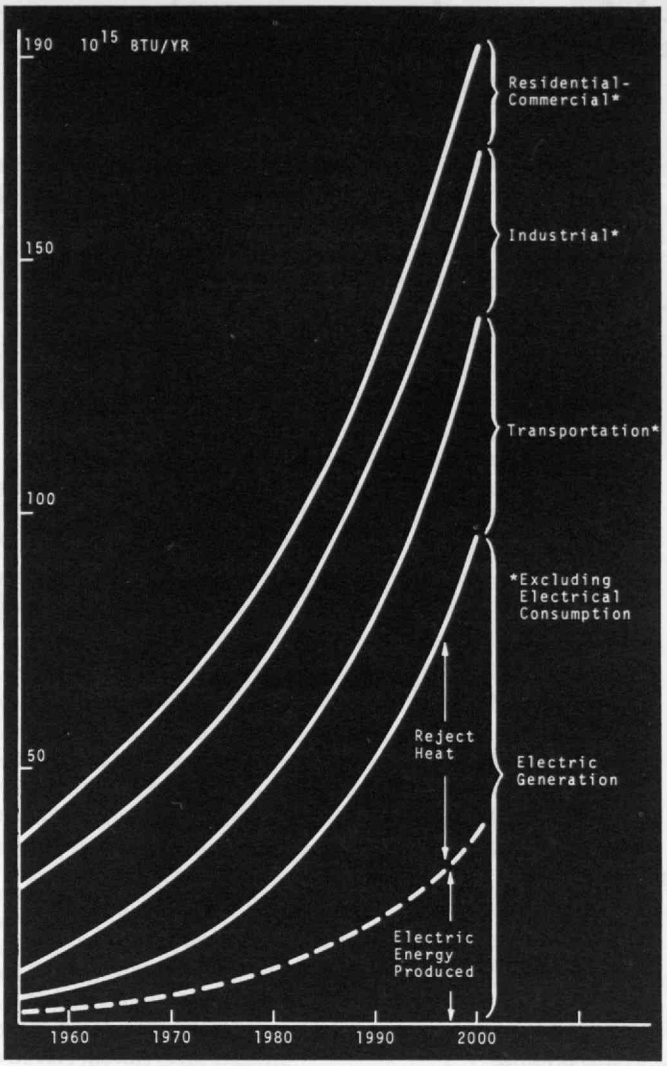
Enthusiastic applause greeted this suggestion at an all-day session on "reconciling man's desire for power with the needs of his environment" during the annual meeting of the American Association for the Advancement of Science. Jaske had pointed out that by the year 2000, according to current projections, the total release of energy to the environment in the Boston-Washington "megalopolis" of that era will exceed 30 per cent of the incident energy from the sun.

An examination of national energy policy, he said, would show that "the primary motivating force in the expansion of the use of energy has been the subsidization policy of the federal government." Once the limits of the environment's ability to absorb modification have been recognized, it should be possible to bring federal incentives into line with what is truly desirable. "It is time," Jaske concluded, "for national energy policy to receive thorough examination at every institutional level to be certain that man's well-being on earth can survive the welter of obsolete inducements carried over from the Victorian notions of the Fabian Society."

Other speakers at the session examined specific aspects of the environmental effects of power generation:

◇ Karl F. Lagler, a professor at the University of Michigan's School of Natural Resources, drew attention to "the sudden and often cataclysmic ecological changes that occur when a river is dammed to make a lake (often huge) with fluctuating water levels and with a new downstream water regime." Failure to plan for such an all-encompassing change can result in unanticipated side effects ranging from obstruction of waterways by new plant populations to great human hardship due to the disruption of established ways of life. Professor Lagler has recently edited a document on these problems and their solution, entitled *Man-Made Lakes: Planning and Development,* available gratis from the U.N. Food and Agriculture Organization, Rome, Italy.

◇ Wallace B. Behnke, Jr., Assistant to the President of the Commonwealth Edison Co., Chicago, spoke of the difficulty of reducing sulfur emissions from coal-burning power stations. (Even if no more coal stations were built henceforth, 40 per cent of today's would still be with us in 1990, he said.) Much of the available low-sulfur coal



"With projections of total energy release to the environment from the coterminous United States exceeding 190,000 trillion Btu. per year by the year 2000 . . . the time has come for serious examination of national energy policy on a broad front," says Battelle's R. T. Jaske.

is of a kind that requires making modifications in the boilers; and, he said, the removal of sulfur from stack gases on a practical scale is still many years away. Antipollution science and technology are not keeping pace with the demand, and he indicated that the coal industry should take on a larger share of this task.

◇ As if in response to these points, Arthur M. Squires of City College, City University of New York, said flatly that the present pulverized-fuel method of burning coal is obsolete. Its original acceptance in the 1920's occurred because some alternative to grate combustion was needed. At that time there was little concern about the ash that pulverized fuel produced, but only about grit, which it did not.

He agreed that there is no good system for extracting the sulfur from pulverized-fuel effluents and went on to outline current developments in fluidized-bed combustion, notably at the British Coal Utilization Research Association, "which should dispel the aura of inevitability which has tended to protect pulverized-fuel combustion from competition." Dr. Squires visualized fluidized-bed power stations, able to burn low-sulfur coke without difficulty, utilizing the output of plants which extract sulfur from coal during distillation. Radical advances in coal engineering could come if coal engineers enjoyed the same financial freedom which has stimulated their nuclear counterparts.

◇ Harry Perry, Research Advisor to the Department of the Interior's Assistant Secretary for Mineral Resources, foresaw that coal consumption in the U.S. would continue to rise "at least to the end of the century" and examined the consequent impact of mining on the environment. The two most important effects, he said, are the disturbance of land by strip mining (which has twice the productivity of underground mining and now accounts for a third of total coal production) and acid drainage from both strip and underground mines.

"Strip mining, where adequate reclamation is not undertaken, can result in adverse effects on esthetic values, recreation activities, forests, fish and wildlife, land use potential, and most important, on streams. . . . If basic reclamation were applied to all of the approximately 800,000 acres of land disturbed by coal mining that need some degree of treatment, the costs would be in the range of $300 million. . . . If only those areas causing the most serious damage were to be treated, the total costs could be reduced to $120 million." Beyond this simple repair process, current knowledge makes it possible to rehabilitate the land—that is, develop it for use. This would raise the total cost to $480 million, but at an increased cost-benefit ratio.

Acid mine drainage, said Mr. Perry, affects nearly 11,000 miles of American streams, and is estimated to cost water users $3.5 million a year in measurable ways, leaving aside "general environmental degradation." Treatment methods, which are technically similar to those proposed for desalination, are expensive. The State of Pennsylvania alone estimates that it would cost between $1 and $2 billion to clean up its own acid drainage, mostly from mines that are now disused, and has in fact allotted $150 million over a ten-year period for this purpose. It will be possible only to treat selected priority areas.

But, Mr. Perry concluded, "with proper attention to mining methods and control procedures, current mining can be undertaken with only minimal effect on the environment." The expense "must be viewed as part of normal business costs."

An "Airporter" train setting out from Hopkins International Airport to Cleveland's city center.

Airport Railroad

Tokyo, Brussels and—for over a year now—Cleveland: these three cities form what the Cleveland Transit System calls "an elite group." They and apparently no others are connected to their airports by rapid-transit systems of the kind shown in the photograph, namely railroad trains. The picture (provided by the Republic Steel Corp.) shows Cleveland's Hopkins International Airport and one of its "Airporter" trains.

The number of passengers per day, expected to be 2,000, proved to be double this figure. Hubert Humphrey likes it, as do Mrs. Orville L. Freeman, the President of Pan American Airways, and—reportedly—the Governor of Missouri. The 11 miles from Hopkins to downtown Cleveland takes 23 minutes and costs 40 cents.

In August, the number of Airporter cars will be increased from the present 20 to 30. They cost $251,950 each. The cost of extending Cleveland's pre-existing rapid transit system by four miles, to reach the airport, building five bridges and two new intermediate stations with 1,250-car parking lots, totaled $18,600,000, of which two-thirds came from federal sources.

Vapor Locomotives: A Progress Report

Don't bet—yet—on a steam car to solve the noise and air pollution rising from American highways. But don't write it off as an optimist's vision of utopia, either.

In addition to its low air pollution (because it is a low-temperature, "external combustion" device) and low noise levels, the Rankine cycle vapor engine has several potential advantages: it is inherently simple, a highly reliable engine which should require little maintenance; it can be simply modified to use whichever of a number of different fuels may happen to be most practical; it is an efficient engine (there is no compression stroke to be powered by the same fuel that drives the crankshaft).

But there are problems. Vapor engines, though simpler than internal combustion engines, may be more expensive to build because the condensers (radiators) and pump must be large and must operate under conditions more extreme than in an internal combustion engine.

George N. Hatsopoulos, a former M.I.T. professor in mechanical engineering who is now President of Thermo-Electron Engineering Corp., is working hard on vapor engine power plants for many applications where power needs range up to 100 horsepower. The company has designed small hermetically sealed engines using organic fluids as the expanding/contracting liquid; because the available organic fluids decompose at high temperatures, these engines incorporate water jackets to eliminate "hot spots" which cannot be designed out of the engine.

These small engines are now being developed for air conditioning and power generation, where their life will be comparable with that which housewives now experience in electric refrigerator compressors. The question now is to increase engine size to provide power for a 3,000- to 4,000-pound vehicle.

Dr. Hatsopoulos, though making no promises to his audience of M.I.T. mechanical engineering students at a seminar late this fall, obviously thinks it can be done and that his company will be building a small-scale version of such an engine in the spring, for testing next summer. His project is funded by the Department of Health, Education and Welfare.

Dr. Hatsopoulos told his audience that his company's small vapor engines seem sure to be "a new power source which will have a profound influence on our own society." But he had "serious reservations" about the larger engines for automotive applications. Even if present technology proves adequate, he said, the automobile industry—with a very large investment in internal combustion technology—and the public are both "very sensitive to cost." He admitted that even the limited market of those car buyers who look for something exotic to drive and are willing to pay extra for it might be "enormous," but he was clearly unwilling to make a claim on even that market at this stage of development.

Cambridge Journal

The Retreat of the Electronic Future

The National Aeronautics and Space Administration's ambitions for the Electronics Research Center, on property adjoining M.I.T. in Cambridge, had only begun to be fulfilled when President Nixon announced the Center's demise this winter. The photos show a model of the site as it was once meant to look and an aerial view of progress as of September, 1969.

The announcement of E.R.C.'s closing precipitated a cacophony from abused Cantabrigians—industries which had originally vacated the site, housing interests who pitched a tent on the site to dramatize their needs, members of the Cambridge City Council seeking a new City Hall, and others who deplored the whole episode as a shabby way for M.I.T. to gain new real estate.

According to Senator Edward Brooke, N.A.S.A.'s covenant with the city of Cambridge assures that the buildings be used for research of some kind, and this covenant remains in effect until October, 1995. There was responsible talk of their use by the Federal Aviation Administration and later by the Department of Transportation; and there was irresponsible speculation about occupancy by M.I.T.'s Charles S. Draper Laboratory.

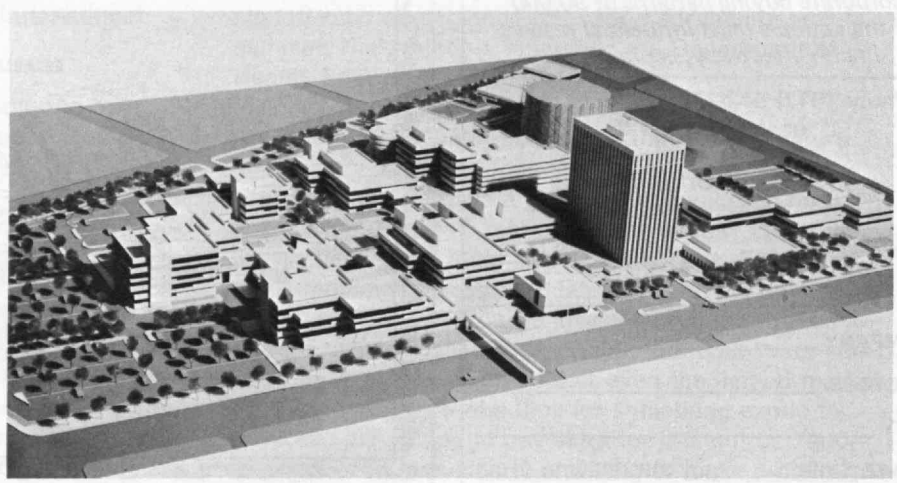
Presidential Science Adviser Lee A. DuBridge, named by President Nixon in mid-January to work on finding federal uses for the Center, subsequently reported that the President's Science Advisory Committee "hadn't come up with anything useful," and that "there is a lot of sentiment around here for just letting the Center fold and letting the people go out and get jobs." This news was communicated to M.I.T.'s Provost Jerome Wiesner in his capacity as a member of Governor Francis Sargent's Massachusetts Science and Technology Foundation, a group which devoted its first meeting to the problem of the E.R.C. site. At press time the questions remained unanswered; but James L. Sullivan, City Manager of Cambridge, was promising that the land not yet committed to buildings would be used for housing—and so the tent-dwellers may yet have had the last word. (Artist's model: N.A.S.A.; photo: Cambridge Redevelopment Authority)

At about this time, the new buildings for the Electronics Research Center, Cambridge, of the National Aeronautics and Space Administration were to have been completed and the staff of 2,100 assembled and moved in. That was the timetable given to Congress when, in March, 1964, it formally authorized the construction of the Center.

In fact, six buildings were in various stages of completion and one unstarted, and the staff (mostly working in rented quarters in nearby Technology Square) numbered 850, when N.A.S.A. Administrator Thomas O. Paine announced late in December, 1969, that the Center would be closed down.

The announcement revived a dispute, dating from the first conception of the Center, between those who considered it a technically unjustified porkbarrel gift to John F. Kennedy's home town and those who held that the Center filled a real need for space-oriented electronics research. The former consider that their diagnosis has been vindicated by the death of the patient; the latter, that forward planning is not what it used to be, and that the still desirable E.R.C. is a tragic victim of economic forces having nothing to do with either the exploration of space or distribution of political benefits.

Both schools of thought were represented within the space agency when, "in the process of presenting N.A.S.A.'s Fiscal Year 1964 Budget to the President for approval, the Administrator of N.A.S.A. initially discussed the Boston location in mid-October, 1962." The quotation is from a July, 1963, report of N.A.S.A.'s Electronics Research Task Group, which continues: "It was decided at that time that the proposed Center would be handled dis-



cretely [*sic*] within the Executive Department until a reasonable time had elapsed after the November elections in order to obviate the impact this proposal might have had." The Task Group was able to report that the Corps of Engineers was doing a "preliminary screening" of sites in the Boston area which was formally initiated by N.A.S.A. in February, 1963.

Congress, in the process of authorizing the 1964 budget, stipulated that no money should be spent on the Center until N.A.S.A. had provided "a detailed study of the geographic location of, the need for, and the nature of the proposed Center." An Area Survey Committee was formally established in October, 1963, to "survey potential geographic locations for the Center" and to produce a "national, regional and area survey on the industrial, professional and academic concentrations in the electronics field to assist in evaluating these locations."

In January, 1964, N.A.S.A. produced the "detailed study," with a 300-page area study which made the choice of Boston out of nine possible areas seem reasonable but not obvious. The case for the Center was that, in its future activities, N.A.S.A. would need electronic components based on new fundamental research. Electronics represented a major share of N.A.S.A.'s expenditures and would continue to do so. So as not to be at the mercy of other people's research activities, the Administration should therefore develop its own basic electronics research capabilities. Electronics research underway at, or administered from, other N.A.S.A. centers provided for present needs, but a new center devoted specifically to electronics—concentrating on new components rather than operational systems—was the best way of ensuring that future requirements (particularly for very high reliability) would be satisfied.

The January, 1964, study was quickly approved by Congress and its recommendations for the organization of the Center accepted: five divisions, all concerned with fields of research rather than with specific mission requirements. That the research was intended to facilitate interplanetary, and not merely lunar, missions was not explicitly made clear, but this was an underlying assumption "well understood by N.A.S.A. and the Congress" according to one senior E.R.C. official of that time.

The timetable for construction was sketched out in a chapter of the January '64 report whose theme-statement runs: "The build-up of facilities and personnel must be carefully planned and closely coordinated if the operation is to begin as quickly and efficiently as possible." In 1967, the U.S. Comptroller General was moved to draft a document contrasting this timetable with actual progress, attributing the very considerable discrepancy to the "lack of due regard on the part of management that basic planning, from the outset, was not being directed to the design of a total facility that could be constructed within the cost estimate that had been justified to and approved by the congressional committees in 1964."

Work of the Electronics Research Center

The N.A.S.A. Electronics Research Center was set up "to increase the agency's capability in space and aeronautical electronics by providing the background of knowledge and advanced technology needed to overcome present deficiencies."

A prime objective was increased reliability, which was a subject of particular concern in the early 1960's. Also mentioned in the 1964 mission statement were reductions in size, weight, and power requirements and the development of electronics for high-temperature, radiation, and vacuum environments.

What follows is a representative selection of topics from a recent progress report. Selection is necessary: the contents list of this report runs to 12 pages.

Power control for ion propulsion.
Thermionic nuclear-to-electric conversion.
Superconducting switches.
Self-healing fuses.
Fuel-cell electrode processes, studied by holography.
Monitoring and failure prediction of electronic systems, particularly for S.S.T.
Semiconductor microwave devices.
Light modulation by liquid crystals and by Faraday rotation.
Radiation-resistant components to work above 450° C.
Low-temperature (500-600°C.) thermionic cathodes.
Microholographic observation of failure modes of monolithic circuits.
Integrated-circuit inductors.
The updating of N.A.S.A.'s *Microelectronics Device Data Handbook.*
Ultraclean airflow for reliability research.
Computer-aided component design, analysis, and quality control.
Leak detection in airtight encapsulations.
Infrared spectroscopic observation of devices during manufacture.
Interactions of electromagnetic waves in solids.
Semiconductors—interrelations of electromechanical effects; electron-spin-resonance impurity observation; basics of transport phenomena and of avalanche initiation; ion-implantation doping.
Physical effects of stress-waves in solid electro-acoustic devices.
Low-energy electron diffraction.
Nature of the superconduction transition.

The majority of the research for which E.R.C. is responsible—perhaps 70 per cent—is contracted out to industrial and academic laboratories, not only in the Boston area but across the country. An example of a significant piece of work farmed out to M.I.T.'s Draper Laboratory is a high-sensitivity accelerometer project, worth $8 million, which has been variously described as basic (but not having a specific application) to future aircraft and space systems, and as relevant clearly to military rocketry and possibly to aircraft blind landing.

By 1967 the Center was also being criticized for the very characteristic that had been most central to its conception—its concentration on basic research for the future, not on current applications. Under a new director, James C. Elms, it was reorganized into three divisions, with plenty of room in the structure for research applicable to recognized needs—for example, air traffic control and blind landing. One high-ranking outside observer noted that the Center had developed "a desire for a mission of its own."

Undoubtedly the Center's personnel, albeit numerically rather weaker than the strength planned for fiscal 1967, are nevertheless an impressive assembly of talent. A number of their innovations have earned the accolade of a mention in the President's Report to Congress on Aeronautics and Space Activities—items such as the gallium antimonide pressure sensor and the scanning electron "mirror" microscope (in which an electrically charged sample imposes its image on the electron beam without actually being impacted by electrons). But the Center has not yet reached the point of making a dramatic contribution to some clearly visible and budget-worthy achievement. The other N.A.S.A. centers did not reduce their electronics efforts, and E.R.C., on its showing so far, remained open to the charge of redundancy for which it has been sentenced.

If the growth of the Center had gone according to the 1964 rule book, and if public enthusiasm for the deeps of space had remained what it was in J.F.K.'s time, and if the U.S. economy had not fallen upon hard times, the story might have been different.

Irwin W. Sizer, Dean of the M.I.T. Graduate School, is chairman of a high-level committee which is handling possible cases of M.I.T. students and staff found guilty—by M.I.T. or in court—of participating in serious campus disturbances. If such people are receiving federal support, their bread and butter, it must be withdrawn. Dean Sizer says that the Institute is "gravely concerned" about the ticklish question these laws raise with respect to the campus' right to police itself free of external influences. (Photo: Donald L. Estes, Jr.)

With the Loss of Bread and Butter Goes Your Freedom

Somewhere among the snarled relationships between Washington and the nation's campuses are a set of laws which raise the ugly possibility of federal regulation of university discipline.

Passed during congressional backlash moods after disorders on several campuses in recent years, the laws require colleges to determine and to report those individuals attending or employed by them who are found guilty of "participation" in "serious campus disturbances" and who receive federal funds; the institutions must deny that individual his federal money for a period of two years.

Although to date no M.I.T. student has been denied funds under the laws, the issue has been a subject of grave concern at M.I.T. since last May, when the Senate Subcommittee on Investigations, chaired by conservative Democrat John M. McClellan (Ark.), subpoenaed M.I.T. to report to it the financial status of six students charged civilly after the occupation of University Hall at Harvard in April. M.I.T. complied; the one receiving federal aid successfully appealed his conviction; hence he kept his funds. To anticipate future questions, a high-level committee was set up, chaired by Irwin W. Sizer, Dean of the M.I.T. Graduate School, to determine Institute policy vis a vis these laws.

The specific laws are, in sum:

◇ The Higher Education Amendments of 1968 (P.L. 90-575), Section 504 (a) on National Defense Education Act Title IV grants, denies to an individual the balance of his grant if "the institution determines that" he "has been convicted by any court of record of any crime which . . . involved the use of (or assistance to others in the use of) force, disruption, or the seizure of property under the control of any institution of higher education" and that such crime was of a "serious nature."
◇ Section 504 (b) of the same act requires that funds be withheld from any person found guilty by the college of "willful refusal" to obey "a lawful regu-

lation" of the college and that the refusal was "of a serious nature."
◇ Department of Health, Education, and Welfare Appropriations Act of 1969, (P.L. 90-557), Section 411, broadens the cut to include even applicants for N.D.E.A. Title IV loans or grants (previous bills deal with recipients only).
◇ Section 706 of the $2.3 billion appropriations bill for the Departments of Justice, State, and Commerce which was signed by President Nixon in December extends the same kind of action to those on grants from any of the three departments, and adds a requirement that colleges report quarterly or every semester that they are in compliance.

To date legislation covers funds from the Departments of Defense (N.D.E.A. money), Health, Education and Welfare, Justice, Commerce, and State, and the National Aeronautics and Space Administration and the National Science Foundation.

However, there are two key—still unanswered—questions. One is how strictly Washington will enforce the laws. For example, the quarterly report requirement is considered a "policing" measure, yet when he signed the bill, President Nixon said: "The federal government is ill-fitted to play the role of policeman on our college and university campuses. . . . In passing Section 504, the Congress carefully protected the value of academic freedom. . . . But this approach is not the one followed in Section 706. . . . I do not interpret Section 706 . . . as placing the government in the role of a campus policeman."

But Congress has repeatedly considered measures which impose heavy penalties on universities failing to comply—for example, by cutting all federal funds to them. And, although no such measures have passed yet, *The Chronicle of Higher Education* recently quoted one Congress watcher as saying, "The campus unrest issue is not dead in Congress; it is only sleeping."

The other central question is how the universities will respond. Dean Sizer has listed a number of alternative postures for any university: it can contest the constitutionality of the laws in court; it can act as a buffer between the individual and the government agency—for example, by staking out its own definition of "participation" in a "serious" disturbance; in cases where the individual loses his federal grant, the university can if it wishes help him find other assistance; or, while complying with the law, the university can also enable the individual to defend himself—for example, with the aid of a special legal defense fund for the purpose.

The dilemma is not small for the university, Washington, or the student. Dean Sizer summarizes: "Being reprimanded by your peers and having your bread and butter taken away are two very different things."

The A.A.A.S. Goes Out to Meet the Youthquake

Ever since its origins in the Association of American Geologists and Naturalists in the 1840's, the American Association for the Advancement of Science has steadily broadened its membership and purpose. Recently, in October, 1969, its Board of Directors adopted a policy statement proposing that the organization's "main thrust" for the 1970's would be "a major increase in the scale and effectiveness of its work on the chief contemporary problems concerning the mutual relations of science, technology, and social change . . ."

The sense of the statement was expanded in three resolutions: to increase membership by a factor of 10 (into other professions and among young people); to improve communication to the public at large; and to take needed organizational steps to "focus" on specific high-priority problems expected to be of national importance in the 1970's.

"A Threat to Democracy"

M.I.T. is typical of many colleges this year in its grave concern over federal laws which deny grants, loans, and scholarships to students and staff found guilty—internally or civilly—of participating in campus disturbances (*see left*). Although M.I.T. itself has made no formal statement about its concern that such "policing" encroaches on the internal affairs of the university, Irwin W. Sizer, Dean of the Graduate School who is chairman of a high-level committee studying Institute policy in the matter, says that many M.I.T. administration members have spoken out privately (presumably some in Washington) against the laws.

Characteristic of the strong feeling shared by the community is the comment of Robert Alberty, Dean of the School of Science: "The federal government," he told *Technology Review,* "ought to leave questions of discipline up to the universities. These questions aren't something which can be practically operated from Washington, mainly because individual situations are so complicated. It is too early to evaluate how well universities will police themselves; you can't judge what university B will do as a result of what was already done by university A."

Stanley F. Backer, Professor of Mechanical Engineering, echoes: "If the university governs itself effectively, then there is no need for outside pressure. The laws subject the student to dual jeopardy and I don't think that is appropriate at all."

Paul Fox, a graduate student in electrical engineering who is on the special M.I.T. committee, says that "a substantial" group of graduate students can hardly believe the laws are in earnest. "Many ask me why the university can't just ignore the laws," he says.

And Stephan L. Chorover, Professor of Psychology, comments: "Any tendency to introduce secular authority into the atmosphere of the university is deplorable . . ."

Perhaps the strongest comment came from Nobel Laureate Salvador E. Luria, Sedgwick Professor of Biology: "They are repressive kinds of laws, and I hope that they are unconstitutional. They are part of a dangerous trend towards repression and punishment of criticism, which is manifesting throughout the government. Examples of this trend are the repression of demonstrators in Chicago in 1968 and the murder of Black Panthers by police. American citizens should see in every one of these actions and these laws a threat to American democracy."

The Older Generation Won't —Or Will It?—Change

The American Association for the Advancement of Science is the world's largest organization of scientists. A move to expand its membership by a factor of 10 (*see right*), reaching into into new professions and to younger scientists, has broad implications. The decision rests with the Board of Directors of A.A.A.S., one of whose members is Richard H. Bolt, a founding partner of Bolt, Beranek and Newman of Cambridge, Mass., and a one-time member of the M.I.T. faculty. He commented on the new thrust to *Technology Review*.

"I hope we will learn from this first Youth Committee of things the A.A.A.S. can do to reach more young people. The A.A.A.S. is a gray-bearded sort of organization, and it will have to change somewhat to do this. Its British counterpart, for example, the British Association for the Advancement of Science, has a youth chapter; its members meet and discuss science and take trips together long before they reach college age."

Dr. Bolt, himself an employer of many an engineer, is enthusiastic about the part of the new thrust which aims at expanding A.A.A.S. membership into the engineering community. Engineers have always been accommodated in the A.A.A.S. but have never been a force in its affairs.

In discussing the A.A.A.S.' proposals to involve youth, Dr. Bolt recalled his experiences before and during the 1969 Boston annual meeting of the organization, at which some activists demonstrated. His view is that this meeting gave those activists a chance to see what he believes is the fallacy of two of their basic assumptions. They assume, he says, that the establishment cannot change—but the A.A.A.S. proved it could. And the activists could see—if they would—that many scientists do in fact understand some of what the activists call "basic" problems. Too often, radicals assume that anyone in the older generation won't.

Dr. Bolt thinks that the current trend among young scientists and graduate students to move from "pure science" research into more policy-related fields, such as ecology and pollution, is altogether healthy. "I take a broad view of education," he explained, "and I think a person with a Ph.D. in high-energy physics is perfectly well equipped to do all sorts of different things—not just high-energy physics." He is "delighted," he says, that this kind of young person will help affect the future course of the A.A.A.S.

To implement these resolves, especially with respect to students and younger scientists—now a negligible portion of A.A.A.S. membership—the Board then appointed a 12-member Committee of Young Scientists to make specific recommendations.

The chairman of the Committee is Mack Lipkin, a fourth-year student at Harvard Medical School (who is on leave from Harvard to work on the Committee full time). So far, the Committee (its members are drawn from across the country) has been interviewing the potential A.A.A.S. clientele of young scientists—graduate students, research assistants, untenured faculty, high school people, and so on.

According to Mr. Lipkin, one of the group's goals is to identify the needs of these groups and to determine which of them should be met by the A.A.A.S. A guiding principle is that "the A.A.A.S. should not commit itself to any single course or type of program, for this would limit its effectiveness. Since the needs of each campus vary, it should commit itself to a diversity of experiments."

Young people have unique educational and informational needs, so the Committee began by listing those of scientists and nonscientists in high school and before, in college or other professional training, and employed. Now they are identifying which of these are being met already. Eventually they will try to recommend which can be met by the A.A.A.S. Example: scientists who are in training need information on, among other things, the following: research openings, the social role of science, science ethics, the work of their own discipline in socially related areas, available internships, and frontier areas in their disciplines. How can the A.A.A.S. help them?

Education includes public information, and Mr. Lipkin is critical of the A.A.A.S. for not speaking more to the public. Excellent as it is for scientists, he says, the weekly magazine, *Science,* is not specifically aimed at the average man. He thinks the A.A.A.S. needs other means of bringing science-related problems and alternatives before the general public. Possibilities include a national speakers' bureau, active lobbies, a nationally syndicated news column, and so on.

A second line of the Committee's research has been to explore the options open to the A.A.A.S. as an organization. They are studying the A.A.A.S. Council meeting minutes, budgets, committees, and constitution, all to recommend ways in which the Association can become more effective at the scientist-public interface, especially with respect to youth. The Youth Committee has also done some organization of campus-based committees which can study the ways in which the A.A.A.S. can aid campus groups in meeting these needs.

Mr. Lipkin thinks it likely that the Committee will ask the board for a permanent youth advisory committee to oversee the new efforts. "Our report will define the needs of the constituency and outline how the A.A.A.S. can begin to meet them," he says.

Word Games to the Lesser Antilles . . . and Back Again

John Forester reports that a factory-wired PC board on my amp may have an incorrect component. If further tests corroborate this thesis, Dyna can expect a rather poignant letter and I can expect some music from my system. Here's hoping. Since this month's installment is rather lengthy, I shall dispense with further small talk and get right down to the problems.

Problems

Frank Rubin proposes the following:
21 Define two functions, f and g recursively by

$$f(n, a) = \begin{cases} a & \\ 1 \div \log f(n-1, a) & \end{cases}$$

$$g(n, a) = \begin{cases} 1/a & \\ g(n-1, a)/f(n, a) & \end{cases}$$

in each case if $n = 0$ and $n > 0$.
Then determine whether either of the following converge:

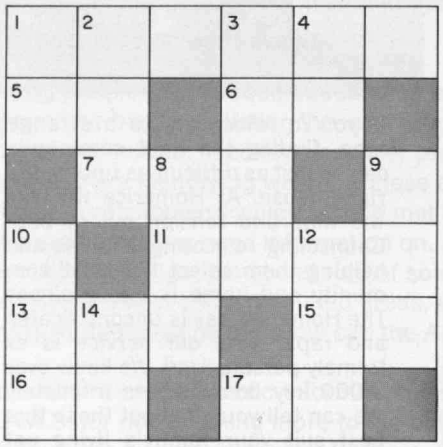
$$\sum_{n=1}^{\infty} g(n, n)$$

$$\sum_{n=1}^{\infty} g(n, 2)$$

22 Recall problem 26 of last year:
Find the smallest integers m and n such that $m - n^3$, m, and $m + n^3$ are all perfect squares.
Robert L. Bishop wants you to show that there are infinitely many solutions to it (easy), and he wants an exhaustive description of them.

The following excellent problem appears to be unsigned, so I cannot credit anyone for it. Will the real author please stand up?

23 So many of our friends have asked about the boat in which we cruised the Lesser Antilles and about the crew that we have prepared a simple diagram which answers most of their questions:



The crew of five were the skipper, first mate Joseph, navigator Peter, deck hand Moses, and cook Able. They all voted for Eisenhower. The total miles shown on the taffrail log was twice the number for the first nine days plus exactly 200 miles. However, we had the log carefully checked and found that for each mile registered we had sailed 6,120 feet, so the distance sailed was slightly greater than that shown on the log. As to the crew, it so happened that if Peter had been 14 years older the skipper would have been twice the average age of his crew. Also if the skipper had been 13 years older his age would have equaled the sum of the ages of the three youngest members of the crew. The dimensions of the boat, sail area, and ages of crew can now be easily ascertained by completing the diagram and using the following clues.

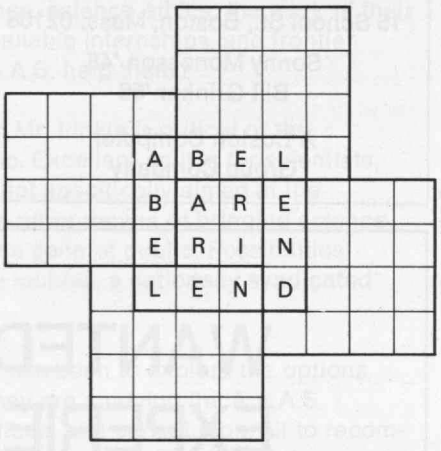
Across
1 Yards sailed in 9 days
5 Age of first mate
6 Twice the age of Joseph
7 Miles logged in nine days plus 1 down
11 Square of 4 down minus 2 down
13 Total miles logged
15 Age of Moses
16 Length overall
17 1 down reversed

Down
1 Cube of beam in yards or square of draft in feet
2 Miles logged in nine days
3 Area of mizzen times beam
4 Two times 5 across
8 Length overall times draft
9 Area of mainsail or twice area of mizzen plus sum of digits of 11 across
10 Area of mainsail plus length overall
12 Low water length plus length overall plus draft plus beam
14 Age of Able

24 James J. Heyman wants you to construct a triangle given the three altitudes.

This problem was submitted by Robert S. Cox and interpreted by Randy Gabel:

25 Complete the following so that all squares contain only words and the word in row i of a square is the same as the word in column i of that square.



Speed Problems

SD8 Leslie Shipman can punctuate the following (periods permitted); can you?
"That that is is that that is not is not is that it it is"

This speed problem is by "Sincerely" (Doesn't anybody sign letters these days?):

SD9 A man walked into a hardware store and said, pointing to an item, "How much is one?" The answer was 20 cents. "I see," he said, "and how much for 12?" Forty cents was the answer. Nodding approvingly, the man said, "Fine, then I want 912." "That will be 60 cents," said the salesman. The question is, What was he buying?

Correction: In SD2 (October/November) we asked you to find nine points in the plane such that 10 straight lines pass through exactly three of them and no points are colinear. Now the proposer, Frank Rubin, corrects us: we should have specified that no *four* points are colinear.

Solutions

6 Given the equation
$(x + 4)(6 - x) = 9$, solve for x.
One method is simply $x + 4 = 9$, $x = 5$; and $6 - x = 9$, $x = -3$; both answers are correct! The problem is to find a general form of the equation for this method of solution to work.

Douglas J. Hoylman is back and has supplied the following: I interpret the problem as that of finding all equations of the form
$(ax + b)(cx + d) = f$
such that when $ax + b = f$, $cx + d = 1$, and when $cx + d = f$, $ax + b = 1$.
Eliminating the x from each pair of equations, we have
$a[(1 - d)/c] + b =$
$c(1 - b)/a + d = f$,
or
$a^2 - a^2d + abc = c^2 - bc^2 + acd = acf$.
Now if $a + c \neq 0$, then we can solve the left-hand equation uniquely for d:
$d = (a - c + bc)/a$.
But then the right-hand equation gives $f = 1$, which is not a very interesting case. So if we want $f \neq 1$, we must have $a + c = 0$. Then we may choose b and d arbitrarily, and the above equations give $f = b + d - 1$. (Assuming, of course, that $a \neq 0$, or the whole thing becomes trivial.) So the general form is
$(ax + b)(-ax + d) = b + d - 1$,
$a \neq 0$

Also solved by Charles Buncher, Mrs. Martin S. Lindenberg, Roger D. Milkman, George H. Roper, Eric Rosenthal, Frank Rubin, Leslie Servi, John J. Sytek, Jr., Smith D. Turner, and Ralph Wanger, Jr.

7 The contract is 6 no trump by South, and the opening lead is ♦Q:

	♠ x x ♥ K Q x x x ♦ x x ♣ A K Q J	
♠ A Q x x ♥ x x ♦ Q J 9 x ♣ x x x		♠ J x x ♥ x x ♦ x x x ♣ x x x x x
	♠ K x x x ♥ A J x x ♦ A K 10 x ♣ x	

Captain John Woolston had little trouble: "The opening lead is taken by South with ♦A and the clubs and hearts are run. When there are only three cards left in each hand, it is probable that West will hold ♠A, ♦J, and ♦9, while South ends up with ♠K, ♦K, and ♦10. Thus the spade lead from North is taken by West, who loses the last two diamonds. Of course, West could hold other cards, but South is able to adjust—i.e., West ♠A, ♠A and keeps three diamonds, South's monds and drop ♠K in his last discard, thus winning them all; or West ♠A, ♠Q, and ♦J, at worst South loses a spade if West's last discard is ♦9. If West drops ♠A and keeps three diamonds, South's two kings are good."

Also solved by Richard A. Bator, David A. Finnegan, Stanley Horowitz, Elmer C. Ingraham, Leon M. Kaatz, T. D. Landale, Michael Lintner, Private Michael Mann, John P. Rudy, Smith D. Turner, Ralph Wanger, Jr., and the proposer, Frank Model.

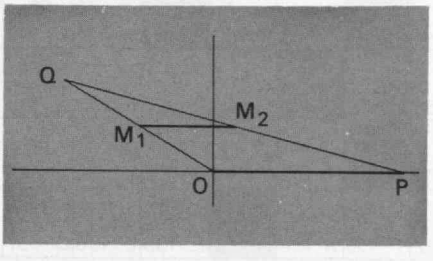
8 If it takes an hour to work a jigsaw puzzle of 100 pieces, how long should it take to do one with 300? (Assume that the puzzles have no regular edges and are of solid color, and that pieces are of similar size and pattern in both puzzles.)

The following is from John P. Rudy: Assume that the amount of time to place the nth piece is proportional to the number of pieces remaining. This says that one looks through the remaining pieces to fill a particular hole. Assume that the first piece takes no time. For the 100-piece puzzle,
$0 + 99 + 98 + 97 + \ldots + 1$
$= (99)(100)/2 = 4{,}550$
For the 300-piece puzzle,
$0 + 299 + 298 + \ldots + 1$
$= (299)(300)/2 = 44{,}850$
The ratio is approximately 9:1.

Also solved by David A. Finnegan, Smith D. Turner, and Captain John Woolson.

9 Connect the three midpoints of a triangle and prove that each of the resulting line segments is parallel to and equal in length to one-half of the opposite side.

Donald Morrison found this rather easy; he says "it is a simple problem found in high school geometry courses" and is most easily proved analytically.



A rectangular coordinate system may be established so that the vertices have the following coordinates: O(0,0), P(2,0) and Q(2a,2b). The midpoints of OQ and PQ are $M_1(a,b)$ and $M_2(1 + a,b)$.
$M_1M_2 = \sqrt{[a - (1 + a)]^2 + (b - b)^2}$
$= \sqrt{(-1)^2} = 1$;
$OP = \sqrt{(2 - 0)^2 + (0 - 0)^2} = \sqrt{2^2} = 2$.
Therefore $M_1M_2 = \frac{1}{2}OP$. The slope, m, of $M_1M_2 = (b - b)/(1 + a - a) = 0/1 = 0$. Therefore, M_1M_2 is horizontal and parallel to OP.

Also solved by David A. Finnegan, Mrs. Martin S. Lindenberg, A. Porter, John E. Prussing, Eric Rosenthal, Smith D. Turner, Ralph Wanger, Jr., and Captain John Woolson.

10 Let G be a group with precisely two conjugacy classes (x and y are conjugate if there is an element a such that $y = a\,x\,a^{-1}$). If G is assumed to be finite, what can be concluded about G?

If instead we assume that G contains a nontrivial element which is of finite order (i.e., there is an x not equal to 1 in G and that $x^n = 1$ for some nonzero integer n), what can be concluded about G?

Thomas H. Sadler has responded as follows:
I found that the order of the finite group must be the power of a prime and that if the group has a nontrivial element of finite order, every element in the group has the same order k, where k is a prime.
Let G be a group with exactly two conjugacy classes C_1 and C_2. Then the identity element $e \in C_1$, say. Now, $x \in C_1 \Leftrightarrow e = a\,x\,a^{-1}$ for some $a \in G$. But $e \Rightarrow a\,x\,a^{-1} \Rightarrow a^{-1}\,e\,a \Rightarrow x = a^{-1}$ (ae) $= x \Rightarrow x = e$. So $C_1 = \{e\}$ $\therefore C_2 = G - \{e\}$; i.e., all nontrivial $x \in G$. This implies in particular that $G \neq \{e\}$.
Now suppose that G has a nontrivial element $x \neq e$ such that $x^n = e$ for some nonzero integer n. (I can safely assume $n > 0$, also.) Let m be the order of x; then $1 \leq m \leq n$, since $x \neq e$ and $x^n = e$.
Now every element $y \in C_2$ has order m.
For $y \in C_2 \Rightarrow x = a\,y\,a^{-1}$ for some $a \in G$.
$\Rightarrow e = x^m = \underbrace{(a\,y\,a^{-1}) \ldots (a\,y\,a^{-1})}_{m \text{ times}}$
$= a\,y^m\,a^{-1}$. $\Rightarrow y^m = e$. Therefore, y has finite order k where $k \leq m$. Now $x = a\,y\,a^{-1} \Rightarrow a^{-1}\,x\,a = y \Rightarrow a^{-1}\,x^k\,a = y^k = e \Rightarrow x^k = e \Rightarrow k \geq m$.
$\therefore k \leq m$ and $m \leq k \Rightarrow k = m$.
So every element in C_2 has finite order m. Furthermore, m is prime. For suppose not; then for some integer p such that $1 < p < m$, $p|m$. Since x has order m and $p < m$, $x^p \neq e$. Since p divides m, $(x^p)m/p = x^p(m/p) = x^m = e$. So x^p has order m/p and $1 < m/p < m$. But every element in C_2 has order m. Contradiction. Therefore, every nontrivial element in G has order m, where m is a prime.
Now suppose that G is finite. Then there is an $x \in G$ of order $k > 1$ (since $G \neq \{e\}$). By the above, k must be prime and every $y \neq e$ in G has order k. Let n be the order of G. By Lagrange's Theorem, $p \mid n$. Suppose there were another prime $q \neq p$, such that $q \mid n$. Then there must be an element in G of order q. But every nontrivial element in G is of order q and $p \neq q$. Contradiction. Therefore $q \mid n$. So the order of G is $n = p^r$ where r is some positive integer.

Neil Cohen, Douglas J. Hoylman, and Dennis W. Sivers also responded.

Allan J. Gottlieb, who studied mathematics at M.I.T. with the Class of 1967, is now on the teaching staff at Brandeis University. Send new problems and solutions to him at the Department of Mathematics, Brandeis University, Waltham, Mass., 02154.

David L. Holt

Tech-Crostic

T 1	C 2	K 3	S 4	R 5	A 6		P 7	G 8	K 9	E 10	I 11		T 12	J 13	O 14	P 15	G 16	B 17			
W 18	Z_1 19		Z_1 20	B 21	W 22		E 23	Z 24	M 25	D 26	C 27	G 28	K 29	Y 30	L 31		Z_1 32	J 33			
M 34	X 35	A 36	T 37	Y 38	U 39	P 40	H 41	B 42		M 43	U 44	R 45	T 46	S 47	Y 48	B 49	V 50	I 51			
K 52	Y 53	F 54	Z_1 55	M 56	L 57	P 58		X 59	U 60		T 61	C 62	W 63		U 64	L 65	B 66	X 67	M 68		
H 69	P 70	C 71		O 72	P 73	A 74	K 75	G 76	M 77	I 78	F 79		V 80	N 81	W 82	Z 83	D 84	A 85	L 86		
	M 87	W 88	D 89		V 90	M 91	U 92		F 93	W 94	K 95	O 96	R 97	L 98	G 99	Q 100	T 101		O 102		
J 103		X 104	E 105	N 106	C 107	V 108	O 109	Q 110		H 111	W 112	J 113	O 114		C 115	N 116	Q 117	M 118	G 119		
E 120		L 121	S 122	B 123		H 124	X 125	R 126	W 127		Z_1 128	I 129	D 130	P 131	T 132		F 133	U 134	J 135		
L 136	R 137		Y 138	G 139	X 140	N 141		P 142	X 143		A 144	W 145	S 146	M 147	P 148	Z 149	O 150	H 151			
J 152	C 153	P 154	M 155	A 156	K 157	Q 158	I 159		O 160	R 161	W 162		L 163	Q 164	S 165	W 166	M 167	G 168			
W 169	S 170		B 171	N 172	Z 173	X 174		P 175	T 176	F 177	Y 178	V 179	D 180		X 181	C 182	P 183	Z 184	I 185		
Z_1 186	J 187	Y 188	A 189	Z_1 190	O 191	K 192	T 193	W 194		E 195	L 196	G 197	N 198	T 199	B 200	H 201	C 202	M 203	F 204		

Use the definitions at the right to help define the words to which they refer; then enter the appropriate letters in the diagram to complete a quotation from a scientific work. The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate the ends of words; when there is no black square at the right end of the diagram, the word continues on the next line.

The correct solution to this Tech-Crostic will appear in the April issue of *Technology Review*.

David L. Holt is Assistant Professor of Metallurgy at M.I.T. He will welcome readers' comments; address him in care of *Technology Review*, Room E19-430, M.I.T., Cambridge, Mass., 02139.

A. Arrangement of troops, vessels, or aircraft, also subdivisions therein.
___ ___ ___ ___ ___ ___ ___
74 85 144 189 36 156 6

B. Manacle.
___ ___ ___ ___ ___ ___ ___ ___
21 200 49 123 42 66 17 171

C. Occurring without ioss or gain of heat.
___ ___ ___ ___ ___ ___ ___ ___ ___
27 71 153 182 107 2 62 115 202

D. Designated; identified.
___ ___ ___ ___ ___
84 130 26 180 89

E. Puts off; rids oneself of.
___ ___ ___ ___ ___
10 105 23 120 195

F. Rogue.
___ ___ ___ ___ ___ ___
93 177 204 54 133 79

G. Boiling up; showing excitement.
___ ___ ___ ___ ___ ___ ___ ___ ___
8 197 139 16 119 76 99 168 28

H. To separate by means of wind.
___ ___ ___ ___ ___ ___
111 41 151 201 69 124

I. An Israelite judge of great physical strength. ___ ___ ___ ___ ___ ___
51 78 129 11 185 159

J. A unit of energy or work (comp.). ___ ___ ___ ___ ___ ___ ___
33 135 103 113 13 187 152

K. Discursive; digressive; desultory. ___ ___ ___ ___ ___ ___ ___ ___
3 95 75 52 192 29 9 157

L. Opposite of word D. ___ ___ ___ ___ ___ ___ ___ ___ ___
121 31 65 98 86 136 163 196 57

M. Gradual breaking under constant stress (2 words). ___ ___ ___ ___ ___ ___ ___ ___ ___
43 147 203 167 34 68 155 87 77
___ ___ ___ ___
91 56 25 118

N. American clock manufacturer. ___ ___ ___ ___ ___ ___
116 141 172 106 81 198

O. Not injured. ___ ___ ___ ___ ___ ___ ___ ___ ___
191 109 14 72 160 102 114 150 96

P. Potassium sodium tartrate (2 words). ___ ___ ___ ___ ___ ___ ___ ___ ___
40 148 183 73 58 70 131 15 175
___ ___ ___
142 7 154

Q. English county bordering on the Thames. ___ ___ ___ ___ ___
158 117 100 110 164

R. Deepest within. ___ ___ ___ ___ ___ ___
97 161 45 5 137 126

S. Person of no influence or standing. ___ ___ ___ ___ ___ ___
122 47 4 170 146 165

T. The ability of particles to be displaced without being removed from their sphere of attraction. ___ ___ ___ ___ ___ ___ ___ ___ ___
46 132 193 101 199 61 1 12 176
___
37

U. A process of printing. ___ ___ ___ ___ ___ ___
44 60 64 92 39 134

V. Ashy pale; of the color lead. ___ ___ ___ ___ ___
179 90 80 108 50

W. Degree of resistance to plastic deformation (2 words). ___ ___ ___ ___ ___ ___ ___ ___ ___
145 112 22 82 162 63 169 194 94
___ ___ ___ ___
88 166 18 127

X. Little world. ___ ___ ___ ___ ___ ___ ___ ___ ___
174 125 140 67 35 104 59 143 181

Y. Foreign or abnormal particle circulating in the blood. ___ ___ ___ ___ ___ ___ ___
53 38 178 30 188 48 138

Z. Message received and understood. ___ ___ ___ ___ ___
173 24 149 83 184

Z_1. Blind or dark spot in the visual field. ___ ___ ___ ___ ___ ___ ___
128 190 32 20 19 186 55

February Tech-Crostic Solution

"The texture of a wire is frequently described as a fiber texture because it resembles the arrangement in natural fibrous materials. In the ideal case it consists simply of orientations having a definite crystallographic direction parallel to the wire axis."
—C. S. Barrett, *Structure of Metals.*

A good way to remember

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☐M.I.T. Director's Chair, Black	Express collect	**$17.95**	_____
			Totals
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	@$14.00 dz.		_____

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TR-370

Institute Review

The 27 Cases Continued

Cambridge District Court Judge Haven Parker on February 11 continued (until March 10) the cases of 27 people charged in connection with the occupation of the President's offices on January 15 and 16. The trial date was set by Judge Parker at the request of attorneys for the defendants. The prosecution had requested an earlier date. The court, acting on M.I.T.'s application, had previously issued a total of 56 complaints against 29 persons. New process was requested against two individuals whose trial has not yet been scheduled.

A full account of the occupation of the offices appears in *Technology Review* for February (*pages 72A-72D*). It occurred following presentation on January 14 of an ultimatum demanding that "all past discipline" (including especially the disqualification of Michael A. Albert, '69, President of the Undergraduate Assembly) be rescinded and that the Discipline Committee be abolished.

Of those whose cases were continued on February 11, 21 are charged with two counts of trespass, one for each day of the occupation; another six are charged with one count of trespass; one is charged with one count of assault and battery; and two are charged with two counts each of disrupting classes. Of the 27, 13 are students, four are members of the staff, one is a degree candidate, not then registered, and seven have no connection with the Institute.

Meanwhile, the office of the District Attorney of Middlesex County reported on February 9 that a grand jury returned an indictment against Stephen F. Krasner, '71, for alleged participation in the manufacture of the instrument used on January 15 to break open a door leading into the President's offices; a violation of the statute involved is a felony. The Institute confirmed its occupation in the investigation that led to the grand jury indictment but refused further comment pending disposition of the case in the courts.

No Institute disciplinary action has yet been taken in connection with the events of January 15 and 16. Existing Institute policy provides that "if a student's infraction involves him both in Institute judicial proceedings and in court proceedings, and if an Institute decision might prejudice his court case, the Institute will hold its decision in abeyance until after the court proceedings have been concluded."

Complaints on which trial is set for March 10 include the following:

Michael A. Albert, '70, trespass (2).
Michael Ansara, trespass (2).
Peter G. Bohmer, '65, trespass (2) and disrupting classes (2).
Richard W. Edleman, '70, trespass (2).
Thomas J. Goreau, '71, trespass (2).
Gregory G. Habeeb, '71, trespass (2).
Robin Hahnel, trespass (1).
Peggy A. Hopper, '71, trespass (2).
Louis A. Kampf, Associate Professor of Literature, trespass (1).
George N. Katsiaficas, '70, trespass (2) and disrupting classes (2).
James Kilpatrick, trespass (1).
Peter B. Kramer, '70, trespass (2).
David N. Krebs, '72, trespass (2).
Jeffrey J. Mermelstein, '72, trespass (2).
William Murray, trespass (2).
Meryl J. Nass, '72, trespass (1).
J. Michael O'Conner, trespass (2).
Susan Orchard, trespass (2).
Miles Rapoport, trespass (1).
William M. Saidel, '69, Technical Assistant Trainee, Research Laboratory of Electronics, trespass (1).
Lillian S. Robinson, Instructor in Literature, trespass (2).
Stephen Shalom, '70*, trespass (2).
F. Charles Simmons, '72, trespass (2).
Frank Taylor, '71, trespass (2) and assault and battery.
Aaron Tovish, '71, trespass (2).
Virginia Valian, Research Affiliate in the Department of Foreign Languages and Linguistics, trespass (2).
Donald E. Wolman, '71, trespass (2).

*M.I.T. degree candidates not registered as of January 15.

Twice as Tough and Twice as Tender

William S. Coffin, Jr., famed Chaplain of Yale University who has become a spokesman for the peace movement, took the occasion of the annual Christmas Convocation at M.I.T. to tell students that they must reject physical violence and instead commit themselves to coping with the violence inside men.

"To define violence in physical terms is ridiculous," he said. "Violence is not individual and messy; it is mass and efficient. The subconscious has no digestive tract and what goes down must come up, either as violence to others or violence to oneself." Rev. Coffin said that under his definition of violence, "we all come out looking bad; . . . we love repression." This is the Christmas lesson: "He who came to be the bread of man was laid in the feed box of animals. And this is still true today!"

Rev. Coffin described the U.S. social structure as violent because of its repressiveness. "It is outwardly orderly but inwardly violent." He said that if the world's population were reduced proportionally to a town of 1,000 people, 60 of them would be Americans but they would control one-half of the total national goods. "That's violence."

American industry is so consumer-oriented, he said, that "every time something is produced, something else is destroyed." Industry "has obscured the sun and the stars and polluted the lakes. We live in a land of idle worship."

Rev. Coffin told M.I.T. students, of which some 5,000 participated in the October Moratorium (*see* Technology Review *for December, 1969, pp. 87-88*), that "in fact, the Moratorium was a group of impudent snobs . . . Where were the sons of Italy, the sons of Lithuania? They were all somewhere else, living the American Dream. But how many of us had the courage and the compassion to tell them that it is the wrong dream? Until they find out that it is the wrong dream," he said, "they will go on looking for scapegoats."

He called for less emphasis on being right and more emphasis on "being loyal to a truth that is good for all." The Middle East, he said, is a good example of two sides which are perfectly right. "The hard line is for weak people, and that includes the people who call cops 'pigs.'

"Nonviolence has nothing to do with passivity and everything to do with resistance," he said. "We must all be twice as tough and twice as tender, so we can, with Daedalus, go out and forge on the smithies of our souls the uncreated conscience of our race. Merry Christmas."

*"Our science courses are such that the teacher gives information and the student picks it up. The student could contribute to the course himself—not by creative scientific work, for which he has no experience yet, but by re-creative participation," says Victor Weisskopf, Head of the Department of Physics (*left*). His suggestion is one of many heard in recent months by the M.I.T. Commission, a blue-ribbon panel which is taking a critical look at M.I.T. and recommending a course for the 1970's. Listening to Professor Weisskopf, and at the focus of the many problems and alternatives before M.I.T. and the Commission, is its chairman, Kenneth M. Hoffman, Professor of Mathematics. (Photo: Richard M. Koolish, '68)*

Hoffman Discusses Commission Participation, Thinking

The following is excerpted from the remarks of the Chairman of the Commission on M.I.T. Education, Kenneth M. Hoffman, Professor of Mathematics, before a meeting of the M.I.T. Faculty on February 18:

"I think there may be a tendency for some people to think of the M.I.T. Commission as an isolated group, shut off in Building 39, only to emerge a year or two later with some very one-sided plans for the future of the Institute. But this is contrary to the spirit of this group. More importantly, it would be an inadequate response to the character and needs of the Institute at this time. . . . Rather, the Commission should be a catalyst for increasing activity and thinking by the M.I.T. community on these issues. This view of the Commission means effectively communicating and working with as many members of the Institute community as possible.

"The Commission members, and those working with us, are involved in a broad variety of issues, and we intend to take the time and energy required to consider each issue seriously. The Commission alone cannot provide an answer to all the problems facing M.I.T., but we can pinpoint the issues and opportunities. And, with the community's participation, we intend to arrive at specific recommendations in critical areas and to propose what we believe are the desirable directions for the future growth and change of the Institute. . . . Obviously it would be futile to try to touch on the many issues which have long-range significance for us. But I would like to describe two of the main thrusts of the Commission's thinking at this point.

"The Commission feels that undergraduate education should continue at the core of M.I.T., and, furthermore, that the problem of adapting it to current generations of students and the range of issues they will face is a primary challenge to the Institute. In order to meet that challenge, we must do several things:

1. Give the students more responsibility for their own education.
2. Provide alternate styles of learning and alternate routes through M.I.T.

The Commission Takes a Deep Look at the Future

Imagine the problems which confront the average student or faculty member at M.I.T. Then describe what society will be like in 20 years and explain what kind of educational institutions it will need. Then, if you are still on your feet, figure out how M.I.T. should get from here to there.

The M.I.T. Commission, an authoritative panel of students and faculty appointed early this fall (*see* Technology Review *for October/November, p. 100*), has a carte blanche to do just that—to outline a path for M.I.T. in the 1970's.

How does such a group begin? A large part of the job, says Commission Chairman Kenneth M. Hoffman, Professor of Mathematics, is making the community aware that the Commission fully intends to propose serious changes for M.I.T. Thus, he says, it requires the best intellectual resources and maximum participation of the whole community. The eye-opening impact of being part of this process was summarized recently by a senior faculty member on the Commission at a meeting with Alumni Association staff: "I've been here for many many years, and I always thought I knew what M.I.T. ought to do and be. But now that I've gotten into it, I realize that I don't have the answers at all."

In addition, of course, there is the job of setting up the necessary task forces, staff, and working groups—and of identifying the considerable body of "experts" whose views should be heard by the Commission.

And, acting on the proposition that the Commission should avoid hiding in an ivory tower and instead prod the whole community to aid in identifying problems and solutions, the Commission was welcomed, heard, and published presentations by anyone—inside or outside M.I.T.—who cares about the future and nature of the Institute. The sample below should indicate the problems being considered—and answers submitted.

1. Has M.I.T.'s role of serving society been too unquestioning of the goals of that society and the uses to which those services are put? Should M.I.T. be a more independent leader for society? Should it be a critic?

◇ "Science and engineering are on their way to producing an almost totally artificial environment, . . . and this raises questions of satisfactorily managing this environment for ourselves. . . . Somewhere there have to be people familiar with the energies, the ideas, and the forces at work in the new artificial environment, people who have some set of criteria to manage it effectively . . ." Elting Morison, Professor of History, Yale University.

◇ "If a culture and a society are to flourish, their conceptual and ethical framework must fit the real and changing environment. Hence, these frameworks must be adaptable, plastic, intrinsically self-critical and persistently

self-revising. No agency in society is better suited to carry out the function of criticism and revision than the university, permeated as it is with the spirit of free inquiry . . ." Salvador E. Luria, Sedgwick Professor of Biology, M.I.T.
◇ "I'd like to see us cultivate a mood here so the faculty could be prophets and take the responsibility of anticipating future needs, of visualizing an improved quality of life. Then, in a fairly simple and natural way, they could teach the students what they think they will need to know 10 years hence if these visions become realities."—Gordon S. Brown, '32, Dugald C. Jackson Professor of Electrical Engineering.

2. Of course, the relation of M.I.T. to society leads to questions about its relation to one of American society's key elements—the federal government; and there are as many opinions on that subject as people:
◇ "There exists the possibility of private funds being restricted so greatly that the institution will become more and more dependent on government funds of one kind or another. I personally feel we need to fight in every way we can to maintain the flow of private funds and our diversification of sources so that we do not become beholden to any one source of funds."—James R. Killian, Jr., '26, Chairman of the M.I.T. Corporation.

3. A key to training people to lead independently and critically is an educational format which permits them to understand the implications and value assumptions of their work:
◇ "I would hope that you would have something to say about how you solve the problems of teaching a sense of what engineering is about."—Professor Morison.
◇ "I think that technology cannot remain separate from the question of how technology is used. . . . The problem in the past has been that the question of how technology is used was not one that was raised inside the university."—Noam A. Chomsky, Ward Professor of Modern Languages and Linguistics.

4. Does M.I.T.'s traditional strength in engineering and the natural sciences further or inhibit its extending into new fields—possibly those of social, urban, and behavioral sciences?
◇ "The Lewis Commission (in 1949) urged that there be a strong interaction between the social sciences, the humanities, the technologies, the sciences, and the natural sciences. To my knowledge, this hasn't happened anywhere in the world . . . ."—Jerrold R. Zacharias, Institute Professor of Physics.
◇ "Experimentation in the affairs of society can seldom be done under the relatively neutral conditions available to the natural scientist since this experimentation generates active involvement in the process of social change. The question of responsibility cannot be separated from the testing of hypotheses: studying society in a scientific, experimental way means interfering with the course of events."—Professor Luria.

Students, faculty, staff and alumni are being asked to serve on Commission panels and task forces on questions of education, the judicial process, finances, the physical environment, and others. And, in large part, the success of the effort will depend on the cooperation of the entire community.

Alumni Can Help Chart M.I.T.'s Future

Intensive efforts are being made to draw alumni into the work of the Commission on M.I.T. Education in their local communities. We hope you'll indicate your interest and the questions which particularly concern you.

_____

_____

_____

Name and address: _____

Return this form to F. G. Lehmann, Secretary of the M.I.T. Alumni Association, Room E19-438, Cambridge, Mass., 02139

3. Invest the education program with a deeper humanism. Students who will apply analytical skills in tomorrow's real world will require a broadly based knowledge and a highly developed set of values which they understand and are able to use and articulate. They will need to be able to evaluate the indirect implications of their own work.
4. Ask some very fundamental questions about the "mix" of our student population as regards culture, sex, interests and age. The Commission is thinking very seriously about whether we could not be more effective by starting with students about two years younger and developing a program of continuing education.
5. Take a hard look at the relationship between teaching and research. It seems important to constantly bring the frontiers of search down into the undergraduate program. Yet is it essential that every member of the teaching staff be a creative researcher? Might not some other structure of the Institute allow us to maintain the quality of both research and teaching?

"A second major focus for the Commission is the development of criteria for choices in research involvement. There has been a great deal of discussion recently about the appropriateness of research. Criteria of quality and uniqueness also seem very important, especially in this period of shrinking resources. . .

"Problems such as these cannot be solved by collecting the pertinent data and drawing some obvious conclusions. Even a serious attempt at their solution will require a sustained effort by many members of this faculty. We are greatly encouraged by a number of initiatives being taken by departments and other groups to examine their own programs. These efforts complement the work of the Commission.

"Let me take the liberty of adding a personal note here. Earlier, I referred to a deeper humanism. Our thinking must cut much deeper than comments about scientists without values or humanists who do not understand science. It seems to me that the overprofessionalization of academic disciplines and the success of science and technology have produced scientists and engineers with too little concern for the effects of their total enterprise, and have resulted in an overemphasis on quantitative methods in disciplines directly concerned with the human condition. We are losing our ability to help our students develop a sense of purpose and direction for their lives in a hectic world.

"This is not a problem peculiar to M.I.T. I think it is a deep intellectual problem. I hope we tackle it head on. At the very least, we should strive for a very deep understanding of the role of science and technology in the world."

Harvey M. Sapolsky, Assistant Professor of Political Science at M.I.T., discussed the problems now facing university research scientists after 20 years of enthusiastic support. There is considerable tenseness over the place of science for science's sake—and the funding it can expect—in a period of shifting national priorities, he told a gathering of Poughkeepsie-area alumni last fall.

"If the Past Has Been Perfect, The Future Is Tense"

The "golden age of science" is losing its luster in the U.S. Indeed, "the entire edifice of post-World-War-II academic science seems to be crumbling," Harvey M. Sapolsky, Assistant Professor of Political Science, told M.I.T. alumni and Poughkeepsie-area students at the Vassar College Alumnae House last fall.

Twenty years ago, said Professor Sapolsky, the nation perceived its problems to be focused on national defense, which is a high-research enterprise; between 15 and 20 per cent of any U.S. defense budget is spent on research. But now we are less concerned about defense than about a host of "human" problems—the plight of the cities, air pollution, transportation, for example—to which we see political issues more relevant than technology; and about the effects of proliferating technology itself.

When defense was at stake, Americans were willing to take the word of the experts, "to abdicate our democratic power to make decisions," said Professor Sapolsky. "But voters live in cities, where the problems are, and there is no tradition of centralization in domestic affairs." Nor is there a tradition of research as a means to progress in these "social" fields: 10 per cent of U.S. health funds are devoted to research, 2 per cent of housing funds, 0.2 per cent of welfare funds.

If science for science's sake is losing its power to attract federal research funds to college campuses, the alternative is to claim federal support for science on the basis of its central role in higher education. "There is a strong political base for this support," Professor Sapolsky agreed. But he warned that such broad-based support is more likely to seek increased numbers and facilities than to maintain the "centers of excellence" concept on which federal science support has been largely based since 1947.

Another problem: the new emphasis will be on "useful" science, and this is not always the best science to meet long-term academic needs for new scientists, new knowledge and new materials.

More than 30 alumni and their guests came to what Robert P. Fried, '46, called "the first meeting of Hudson Valley M.I.T. alumni in many years." Following a reception and dinner they were joined by a number of students and faculty of Vassar and other Poughkeepsie-area colleges to hear Professor Sapolsky's remarks on "Science and Public Policy."

So Long, 1960's

At the end of the decade, *Tech Talk,* M.I.T.'s house organ, published a few statistics on the 1960's at the Institute. Growth was clearly the order of the day.

In 1960 there were 13,128 staff, faculty, students, and other employees; on January 1, 1970, the figure was 19,188. There were 2,600 telephones in 1960, and the Institute used 1,411,121 message units of telephone service in that year. In 1969 the figures corresponding were 8,059 and 4,370,812. There were 41 weddings in the M.I.T. Chapel in 1960, 165 in 1969.

When the Red Cross came to M.I.T. for blood donors in 1960, the result was 564 pints; in 1969 the blood bank was enriched by a record total of 2,013 pints.

For M.I.T. the highlight of the decade was in 1961, when the Institute celebrated its centennial with a notable convocation gathering which included Harold Macmillan, J. Robert Oppenheimer, Paul Tillich, Aldous Huxley, and Herman Kahn. Joanne Miller, Editor of *Tech Talk,* recalls it as "an occasion of academic pomp and panoply seldom seen in this country."

1970 Alumni Fund: "Within Reasonable Distance" of Goals

Despite concern over student demonstrators and a slowing national economy, the 1970 Alumni Fund seems to be headed for a record, according to Carl M. Mueller, '41, Chairman of the Alumni Fund Board.

In the period from July 1, 1969, through February 8, 1970, a total of 11,689 alumni made gifts to the Fund; this is an increase of 2.3 per cent over the comparable period in 1969 and 12.7 per cent over 1968. But Mr. Mueller emphasized especially the results of the 90-day period from November 10 to February 8, when 11.8 per cent more alumni contributed than in 1968-69. The Alumni Fund, Mr. Mueller told members of the Alumni Advisory Council at their January meeting, "is our chance to cast our vote for the Institute in a year of trial."

As of February 8, according to Mr. Mueller, gifts to the Fund since July 1, 1969, amounted to $1,721,233—an increase of $47,755 over the comparable period of last year.

Analysis of these results, according to Kenneth S. Brock, '48, Director of the Fund, "makes it apparent that the decrease is principally attributable to uncertainties surrounding the new tax law and the falling stock market." Yet Mr. Brock believes that the Fund is "within reasonable striking distance" of the goals of 21,500 donors and $3 million.

Alumni Homecoming: The Boston Pops Returns

A special performance by Arthur Fiedler and the Boston Pops Orchestra will be the highlight of the first day's events during the 1970 two-day M.I.T. Alumni Homecoming.

In a new format, major Homecoming events will begin on Sunday afternoon, June 14, and continue through Sunday evening—when the Pops plays in Symphony Hall especially for alumni and their guests—and throughout the day (but not in the evening) on Monday, June 15. Alumni attending reunions on June 13 and 14 will return to the campus to find a full schedule of activities awaiting them by mid-afternoon on Sunday.

In addition to the special Pops performance, Sunday's activities will include the opening of a unique M.I.T. arts festi-

val, incorporating student and staff work in the visual arts, drama, and music. John E. Burchard, formerly Dean of the M.I.T. School of Humanities and Social Science, is making arrangements for a major presentation of little-known M.I.T. activities.

Advances and problems in science and engineering will be the subjects on Monday, when the arts festival continues in competition with a series of lectures and seminars throughout the day. Among the speakers already confirmed are Frank Press, Head of the M.I.T. Department of Earth and Planetary Sciences, on the U.S. space program; Lincoln P. Bloomfield, Professor of Political Science, on prospects for world peace; and James A. Fay, Professor of Mechanical Engineering, on various air pollution problems.

Howard W. Johnson, President of M.I.T., will speak to Alumni Homecoming guests at luncheon, and the day's activities will conclude in the late afternoon with a social hour. Further details and reservation forms will be mailed to all alumni this month, according to the Alumni Homecoming Committee.

1970 Summer Programs

Nearly 70 Special Summer Programs—the largest number by far in the history to the M.I.T. Summer Session, according to James M. Austin, Sc.D.'41, its Director —will be given during the summer of 1970 at M.I.T.

Extending for one- and two-week periods, the Programs are designed as "refreshers" for scientists and engineers in professional practice, research and development, and teaching. Tuition ranges from $250 to $800, depending on subject and length. Further details regarding course content and staff are available from Professor Austin's office, Room E19-356, M.I.T.

The list of 1970 Special Summer Programs includes:

Architecture
Systems Building and Industrialization for New Communities, June 16-20
Plastics in Architecture, June 29-July 3
Computer-Aided Architecture, July 6-17

Economics
The Application of the Methods of Economics to the Problems of Urban Economics and State and Local Public Funds, August 10-21
Forecasting with Econometric Models, August 24-September 4

Civil Engineering
Composite Polymer Systems, June 22-26
Transportation Systems Analysis, June 29-July 3
Formulation and Solution of Problems in Water Resources Planning, August 31-September 4

Mechanical Engineering
Recent Developments in Mechanical Vibrations, June 22-July 3
Nondestructive Testing, June 22-26
Wear in Theory and in Practice, June 22-26
Modern Developments in Heat Transfer, July 6-17
Controlling Brittle and Ductile Fracture in Metals and Composites, July 6-17
Strain Gage Techniques: Lectures, July 13-17
Strain Gage Techniques: Laboratory, July 20-24
Physical Measurement and Analysis, August 17-28

Textile Technology
Properties and Behavior of Fibrous Materials, August 3-7
Structural Mechanics of Fibrous Materials, August 10-14
Physical Measurement and Analysis, August 17-28

Metallurgy and Materials
The Electron Microanalyzer and Its Applications, June 29-July 10
Experimental and Theoretical Analysis of Modern Characterization Methods Applied to Electronic Materials, July 27-August 7

Electronics and Computer Science
Programming Linguistics—The Study of Computer Programming Languages, July 13-24
Image Enhancement, Coding and Recognition, June 29-July 10
Theory and Design of Optimal Deterministic and Stochastic Control Systems, July 20-31
Principles of Optical Communication, August 24-September 4
Application of State-Variable Techniques to Communication Systems, August 13-September 4
Detection, Estimation, and Modulation Theory, September 8-12, 14-18

Chemical Engineering
New Developments in Modeling, Simulation, and Optimization of Chemical Processes, July 8-17
Analysis of Crystallization Systems, July 8-17

Ocean Engineering
Economic and Social Constraints on Ocean Systems Design, July 27-31
Materials for Ocean Engineering Structures, August 10-14
Welding Engineering for Modern Structural Materials, August 17-21
Ship Production Scheduling and Control by Network Methods, August 24-28
Finite Element Methods in Solid and Continuum Mechanics, July 20-24
Nuclear Power Reactor Safety, July 6-10, 13-17, 20-24
Physical Aspects of Nuclear Medicine, July 20-31

Operations and Systems Research
Probabilistic Models: Processes, Inference, and Decision Analysis, August 24-September 4
Introduction to the Application of Modern Estimation Techniques, August 24-28
Design and Analysis of Scientific Experiments, July 6-17
Analysis of Public Systems, August 17-21

Chemistry
Infrared Spectroscopy: Technique, August 3-7
Infrared Spectroscopy: Applications, August 10-14

Magnetism and Magnetic Materials
Industrial Applications of Modern Magnetics Technology, June 22-July 3
Topics in Statistical Physics, with Emphasis on Magnetic, Superconducting, and Liquid Crystal Phase Transitions, July 6-10
Applications of Plasma Physics to Gas Lasers, July 27-August 7

Nutrition and Food Science
Fermentation Technology, June 22-26
Dehydrated and Intermediate Moisture Foods: Scientific Principles and Recent Technology, June 22-26
Advances in Biomedical Sciences Pertinent to Periodontology, June 22-26

Management
Industrial Dynamics: Policy Design and Analysis of Complex Industrial, Economic, and Social Systems, June 16-26
Models for Financial Management and Long-Range Financial Planning, June 22-July 3
Capacity Planning: Production and Distribution Systems, June 22-26
The Management of Job Shops, June 22-26
Project Organization and Planning Models, June 29-July 3
Design and Control of Distribution Systems in Manufacturing Organizations, June 29-July 3
Investment Management and Analysis, July 20-24
Management of Research and Development, July 20-31
Introduction to Computer Programming: The Process and the Technology, August 10-14
Computer Programming: Current Technology and Applications, August 17-21
Systems Analysis and Design for Operational Control, August 24-28
Management Information Systems: Conceptual Framework and Current Applications, August 24-28
System Simulation and Modeling, August 31-September 4
Management Information Systems and Management Decision Making, August 31-September 4
Management Science in Marketing, August 17-28
Mathematical Programming, August 24-September 4
On-line Decision Systems for the Marketing Manager, August 24-28
Policy Seminar for Manufacturing Executives, August 31-September 4
The Management of Human Resources, September 14-18

Technical Writing
Communicating Technical Information, August 24-28

George M. Humphrey, 1890-1970

George M. Humphrey, a Director of the National Steel Corp., former Secretary of the U.S. Treasury (1953 to 1957), and Emeritus Life Member of the M.I.T. Corporation, died in Cleveland, Ohio, on January 20; he was 79 years old.

A native of Cheboygan, Mich., Mr. Humphrey studied at the University of Michigan, from which he received the LL.B. degree in 1912, and he then entered the practice of law in Saginaw. Six years later he joined the M. A. Hanna Co., of which he was named Chairman of the Board in 1952.

Mr. Humphrey was Chairman of the Executive Committee of the National Steel Corp. and Chairman of the Board of the Pittsburgh Consolidated Coal Co. for a number of years, and he was also a Director of the National City Bank of Cleveland, Phelps Dodge Corp., Industrial Rayon Corp., and Iron Ore Co. of Canada. He was elected to Life Membership on the M.I.T. Corporation in 1958, becoming an Emeritus Life Member in 1963, following membership on the Visiting Committee to the Department of Metallurgy.

E. H. Huntress, 1899-1970

Ernest H. Huntress, '20, who served M.I.T. in a variety of faculty and administrative assignments for 35 years, died in a Melrose, Mass. nursing home on February 1; he was 71 years old.

Professor Huntress was appointed to the M.I.T. faculty in organic chemistry in 1929, two years after he completed his Ph.D. in the Department of Chemistry; he advanced to the rank of Associate Professor in 1935 and Professor in 1941, and he was known for research on the identification of organic compounds and for the use of chemicals which fluoresce in ultraviolet light. He served as head of the Department's undergraduate work in organic chemistry for seven years and as Chairman of its Graduate Committee for 11 years.

For two years beginning in 1950 Professor Huntress served as Deputy Dean of the Graduate School, and he was Secretary of the Graduate School from 1956

Kane on M.I.T.

Henry B. Kane, '24
Director of the M.I.T. Alumni Fund,
Emeritus

until his retirement in 1963; meanwhile, he was Director of the Summer Session from 1952 to 1956. Professor Huntress had been Chairman of the Northeastern Section of the American Chemical Society (1938-39), and he was active in other professional societies and as a member of the Board of the Technology Press.

A Gift and a Committee for an Underwood-Prescott Professor

Two "firsts" are represented by the M.I.T. announcement late last fall of a new chair in the Department of Nutrition and Food Science to honor the late William L. Underwood, grandson of the founder of the William Underwood Co., and the late Samuel C. Prescott ('94), the first Dean of Science at M.I.T.

It is the first endowed chair in the field of food science in the U.S., and it is the first endowed chair at M.I.T. sponsored jointly by an industrial company and the Institute.

The Underwood-Prescott Professorship was announced during the dinner preceding the 1969 Underwood-Prescott Lecture (in October) by James R. Killian, Jr., '26, Chairman of the Corporation, and George C. Seybolt, President of the William Underwood Co. The Underwood Co. has pledged a "substantial part" of the $600,000 endowment required for the professorship, and a national sponsoring committee is being formed to obtain the balance needed, Dr. Killian said.

Dr. Killian, acknowledging the Underwood gift at the dinner, pointed out that support for faculty positions strengthens "the central purpose of an educational institution. The grant also represents," he said, "understanding on the part of the company of the unfulfilled opportunities for education and research in this field."

Mr. Seybolt's statement at the dinner expressed the company's purpose of commemorating "in perpetuity two men who demonstrated how the public interest could be served by combining the resources of education and industry."

It was in 1896 that Dr. Prescott, then a member of the M.I.T. staff in the Department of Biology and Public Health, and Mr. Underwood, about to become a lecturer at M.I.T., published their first joint paper on food spoilage and its prevention through sterilization. This and their later work established that the spoilage of canned food could be prevented by the use of proper thermal processing.

Members of the sponsoring committee for the Underwood-Prescott Professorship include:

W. Gardner Barker, '37, President and Chief Executive, Thomas J. Lipton, Inc.

Philip K. Bates, '24, retired General Manager of Research, Carnation Research Laboratories.

Samuel Berke, '15, retired Chairman and President, Mr. Boston Distiller, Inc.

Robert H. Cotton, '39, Vice-President, Continental Baking Co.

George P. Gardner, Jr., General Partner, Paine, Webber, Jackson & Curtis.

Robert L. Gibson, Jr., '55, President, California Canners & Growers, Inc.

Samuel A. Goldblith, '40, Deputy Head of the Department of Nutrition and Food Science, M.I.T.

Earle A. Griswold, '23, retired Vice-President and Director, Tampax, Inc.

Ward J. Haas, '43, Vice-President, Warner-Lambert Pharmaceutical Co.

William H. Lang, '22, President, Foley Brothers, Inc.

Stephen P. Mugar, Honorary Chairman, Star Market Co.

Nevin S. Scrimshaw, Head of the Department of Nutrition and Food Science, M.I.T.

George C. Seybolt, President, William Underwood Co.

John C. Sluder, '41, Vice-President, Nestle Company, Inc.

Charles A. Thomas, '24, retired Chairman, Monsanto Co.

Dr. George W. Thorn, Physician-in-Chief, Peter Bent Brigham Hospital, Boston.

John B. Ford Memorial

A $150,000 gift of the Wyandotte Chemicals Corp. will provide a graduate reading room in the new Dreyfus Building for M.I.T.'s Department of Chemistry, which is nearing completion to the east of the Eastman Laboratories.

The room will be established as a memorial to Captain John B. Ford, who—at the age of 80, just 79 years ago—founded the predecessor to the Wyandotte company. The gift was announced jointly by Robert B. Semple, '32, President of the company and a Life Member of the M.I.T. Corporation, and James R. Killian, Jr., '26, Chairman of the Corporation.

Mr. Semple said the company expects the Ford Room to be "an especially fitting memorial for (a man) whose venturesome spirit and remarkable energy prompted him to pioneer" in many areas of American industry. During his long career Captain Ford supplied saddles for the Mexican war, and steamboats during the Civil War; he became the "father of the plate glass industry in America" by founding a company predecessor to the Pittsburgh Plate Glass Co., and he also founded the Michigan Alkali and J. B. Ford Cos. which merged to begin the Wyandotte group.

In accepting the gift, Dr. Killian commented that M.I.T. will be privileged to have this memorial to an "extraordinary person."

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Washington, D.C.	April 4-5	$35/person
Chicago	April 18-19	$35/person
San Francisco	May 2-3	$35/person

Open to all M.I.T. alumni, with preference given to those classes from 1955 through 1967.
For reservations, write to the Alumni Association, 77 Massachusetts Avenue, Cambridge, Mass. 02139, or call 864-6900, x3768 or x7200.

M.I.T. Press Director

Howard R. Webber, Director of the Press of Case Western Reserve University, will come to M.I.T. on July 1 as Director of the M.I.T. Press, succeeding Carroll G. Bowen, who is now President of Franklin Book Programs, Inc.

Mr. Webber, a native of Berlin, N.H., studied at Dartmouth College (B.A. 1956) and Lehigh University, where he taught English before beginning two years' service in the U.S. Army. Later, before taking on his present duties, Mr. Webber was Editor-in-Chief of the University of North Carolina Press from 1959 to 1963 and of the Johns Hopkins Press from 1963 to 1965.

During Mr. Webber's tenure as Director at the Case Western Reserve Press, according to the announcement by Howard W. Johnson, President of the Institute, "the quality of its books in medicine, the social sciences, the classics, art and art history, and literary criticism has been reinforced." Mr. Webber was instrumental in establishing the New York Community Trust Publishing Program for younger scholars and, in cooperation with the Case Western Reserve School of Medicine, a series of educational materials in medicine.

Mr. Webber is a member of the Selection Committee of the National Council on the Arts and of the Board of Directors of the Association of American University Presses. In 1968 he was Chairman of a national conference on research and publishing needs in art and architecture sponsored by the Association and the National Endowment for the Humanities.

In the interim before Mr. Webber's arrival at M.I.T., Michael Connolly, Editor-in-Chief, will serve as Acting Director of the M.I.T. Press, according to President Johnson.

Inventions and "Fledgling Concerns"

The Florida Institute of Technology in Melbourne has made Charles S. Draper, '26, President of its Charles Stark Draper Research Center, which has opened in temporary quarters "pending completion of a planned complex of several future buildings," according to Jerome P. Keuper, President of F.I.T. A Director for the Center remains to be named.

Dr. Draper is Vice-Director for Guidance and Control Programs of M.I.T.'s Draper Laboratory, the Instrumentation Laboratory until it was renamed in January, 1970; he is the Laboratory's founder and Emeritus Professor of Aeronautics and Astronautics at M.I.T., and he continues to devote full time to his M.I.T. assignment.

Dr. Keuper says the Draper Center at F.I.T. will foster "promising inventions of students and others" and will give "special assistance to smaller fledgling concerns." Lamar Washington, Jr., '56, President of ORCA, Inc., of Cambridge, Mass., is reported by F.I.T. as planning "to join others at the new Draper Center to aid in the industrial development of a new device aimed at eliminating electric power blackouts as well as expanding existing sea-mining and sea-farming projects in his companies."

Director of Student Employment

Daniel T. Langdale, Assistant Director of Student Aid, has been named Director of Student Employment at M.I.T., succeeding Edward J. Carey who has accepted an appointment at Harvard University.

While continuing his assignment in the Student Aid Center, Mr. Langdale will also be "responsible for coordinating student employment, both on and off campus," according to Malcolm G. Kispert, '44, Vice-President—Academic Administration.

Mr. Langdale is a native of Cincinnati and studied at Ohio University. He served with the U.S. Army Signal Corps following graduation and later worked for the General Telephone Co. in Indiana before coming to M.I.T. in 1966.

Alumni Calendar

Boston—March 12, Thursday, 12:00 noon—Luncheon meeting, Aquarium Restaurant, 100 Atlantic Ave. Speaker: Gerald W. Blakeley, President, Cabot, Cabot & Forbes. Topic: The Changing Real Estate of Boston.

—April 9, Thursday—luncheon meeting, Aquarium Restaurant, 100 Atlantic Ave. Speaker: Kenneth R. Wadleigh, Vice President, M.I.T.

Cambridge—March 11, Wednesday, 6:30 p.m.—Dinner meeting, Faculty Club. Speaker: Arthur C. Metzger, N.A.S.A. Resident Manager at M.I.T. Instrumentation Lab. Topic: Background and side lights of the Apollo Program.

Cleveland—March 12, Thursday, 6:00 p.m.—Dinner meeting, University Club. Speaker: Dr. John Storer, Director, Department of Thoracic and Cardiovascular Surgery, Huron Road Hospital. Topic: Recent Advances in the Care of your Heart.

—April 2, Thursday—Concert by the combined Glee Clubs of M.I.T. and Mount Holyoke College.

Dallas—March 26, Thursday—Joint M.I.T.-Wellesley Spring Party.

Fairfield—March 24, Tuesday—Speaker: Dr. Gerald N. Wogan, Associate Professor of Nutrition. Topic: Food Toxicology.

Mexico City—March 12-14, Thursday to Saturday—The 22nd M.I.T. Fiesta in Mexico. Write the M.I.T. Club of Mexico City, Reforma 116-804, Mexico 6 D.F. or the Alumni Association for reservations.

Miami—March 5, Thursday, 6:00 p.m.—Dinner meeting, University of Miami Faculty Club. Speaker: Walter A. Rosenblith, Associate Provost. Topic: The Restlessness in Higher Education.

New Haven—April 16, Thursday, 6:30 p.m.—Dinner meeting, Kline Biological Laboratory, Yale University. Speaker: Dean J. Daniel Nyhart. Topic: Student Discipline at M.I.T.

New York—March 17, Tuesday, 12:30 p.m.—Luncheon, Brass Rail Restaurant. Speakers: John G. Borger, '34, Chief Engineer, Pan American World Airways and John R. Wiley, '33, Director of Aviation, Port of New York Authority. Topic: The 747 Jet Transport.

—March 21-22, Saturday and Sunday—Seminar, McAlpin Hotel. Topic: Entrepreneurship and Management, including Technical Entrepreneurship, Finance, Marketing, Information Systems, etc. For information, write the M.I.T. Alumni Center of New York, 295 Madison Ave., New York, N.Y.

—April 1-13—Tour: Spain and Portugal.

—May 14-June 6—Tour: Expo '70 in Tokyo, Japan includes visits to Taiwan, Hong Kong, Bangkok, Singapore, Manila and Hawaii. Cost: $1750 per person includes luxury accommodations and most meals. For further details on both tours contact: M.I.T. Alumni Center of New York, James N. Phinney, Executive Secretary, Suite 1828, 295 Madison Ave., New York 10017.

Northern New Jersey—March 20, Friday, 7:00 p.m.—Dinner meeting, Robinhood Inn, Clifton, N.J. Speaker: Dr. Peter P. Poulos, '47, New Jersey College of Medicine. Topic: Heart Surgery.

—April 25, Saturday, 9:00 a.m.—A morning guided tour of the Great Swamp, including areas normally off-limits to visitors. Picnic lunch will be served.

Norton, Mass.—April 17, Friday, 8:00 p.m.—M.I.T. Symphony Orchestra will perform at Wheaton College.

Philadelphia—April 19, Sunday, 4:00 p.m.—M.I.T. Symphony Orchestra will perform at Swarthmore College.

St. Louis—April 15, Wednesday, 6:30 p.m.—Dinner meeting, Stan Musial's Restaurant. Speaker: Dr. Cameron Meredith, Professor of Psychology at S.I.U., Edwardsville. Topic: A new approach to improving child-parent and child-teacher relationships.

Toronto—March 19, Thursday—Speaker: Dean J. Daniel Nyhart. Topic: Student Discipline at M.I.T.

Washington, D.C.—April 20, Monday, 8:00 p.m.—M.I.T. Symphony Orchestra will perform at George Washington University.

Deceased

Charles L. Bates, '03, January 11, 1970
Howard S. Morse, '03, December 8, 1969
Francis H. Soderstrom, '09, January 24, 1970
Guy H. Little, '10, June 10, 1969
Edward Kenway, '11, December 10, 1969
James M. Beale, '13, November 18, 1969*
Samuel E. Rogers, '13, January 5, 1970
George H. Cole, '15, September 17, 1969
Raymond G. Brown, '16, December 8, 1969
Francisco Sada, '17, summer, 1969
Marion Daniels, '19, January 9, 1970
Ernest F. Perkins, '19, October 10, 1969
Albert B. Reynolds, '19, January 24, 1970*
Arthur R. Gatewood, '21, January 15, 1970.
Francis G. Wells, '22, October 20, 1969
Fred H. Travers, '23, December 10, 1969
Paul L. Wilkins, '23, July 24, 1969
Francis V. Storey, '24, November, 1969*
Douglas D. Donald, '25, November 5, 1969
Ernest C. Greenough, '25, August 26, 1969
John H. Schaefer, '26, October 16, 1969
Glen Jackson, '27, December 26, 1969
Elmer A. Skonberg, '29, January 15, 1970
John K. Vennard, '30, December 27, 1969*
Lincoln Gifford, '31, March 14, 1969
Harry R. O. MacNevin, '31, January 28, 1969
J. Carlos Barousse, '32, March 30, 1969
Edward N. Rosenquist, '32, November 18, 1969*
Norman T. Wilson, '32, November 30, 1969*
James E. Archer, '34, January 16, 1970
Cesar A. Calderon, '36, December 28, 1969
Jack Ostrer, '37, February 7, 1970
Alvin M. Mendle, '38, October 15, 1969
James S. Brierley, '40, April 19, 1968
Beryl J. Roberts, '43, January 22, 1970
Homer C. Knauss, '46, December 5, 1968
Edward P. Stoessel, '49, January 6, 1970
Paul R. King, '59, December 25, 1969

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The tour program covers four areas where those who might otherwise prefer to travel independently will find it advantageous to travel with a group. The itineraries have been carefully constructed to combine the freedom of individual travel with the convenience and saving of group travel. There is an avoidance of regimentation and an emphasis on leisure time, while a comprehensive program of sightseeing ensures a visit to all major points of interest. Hotel reservations are made as much as a year and a half in advance to ensure the finest in accommodations.

INDIA-NEPAL

28 DAYS $1699

An unusual opportunity to see the diverse and fascinating subcontinent of India, together with the once-forbidden mountain kingdom of Nepal. Here is India from the mighty Himalayas to the palm-fringed Bay of Bengal: the great seaport of **BOMBAY;** the magnificent cave temples of **AJANTA** and **ELLORA,** whose thousand year old frescoes are among the outstanding achievements of Indian art; the unique "lake city" of **UDAIPUR;** the walled "pink city" of **JAIPUR,** with an elephant ride at Amber Fort; **AGRA,** with the Taj Mahal and other celebrated monuments of the Moghul period such as the Agra Fort and the fabulous deserted city of Fatehpur Sikri; the famed carved temples of **KHAJURAHO;** the holy city of **BANARAS** on the sacred river Ganges; the industrial city of **CALCUTTA;** a thrilling flight into the Himalayas to **KATHMANDU,** capital of **NEPAL,** where ancient palaces and temples abound in a land still relatively untouched by western civilization; an exciting two day game viewing excursion to world-famous **TIGER TOPS** in the Himalayan jungle of Nepal; the great Indian capital of **NEW DELHI;** and the fabled beauty of the **VALE OF KASHMIR** amid the snow-clad Himalayas. Accommodations of unusual interest include hotels that once were palaces of Maharajas and luxurious houseboats on Dal Lake in Kashmir. Total cost is **$1699** from **New York.** Departures in February, August and October, 1970.

THE ORIENT

30 DAYS $1649

1970 will mark the sixth consecutive year of operation for this fine tour, which offers the true highlights of the Orient at a sensible and realistic pace. As a special attraction, spring and summer departures will include a visit to the **"EXPO 70" World's Fair** in Osaka. Twelve days will be spent in **JAPAN,** divided between **TOKYO,** the **FUJI-HAKONE NATIONAL PARK,** and the ancient "classical" city of **KYOTO,** with excursions to **NARA** and **NIKKO.** A further highlight will be a comprehensive visit to the famous ruins of **ANGKOR WAT** in Cambodia, together with visits of 4 to 5 days in **BANGKOK** and **HONG KONG** and a shorter visit to **SINGAPORE.** Optional pre and post tour stops may be made in **HONOLULU** and the **WEST COAST** at no additional air fare. A complete program of sightseeing will include all major points of interest. Features range from a tour of the canals and floating markets of Bangkok and an authentic Javanese "Rijsttafel" dinner in Singapore to a launch tour of Hong Kong Harbor at sunset and a trip on the ultra-modern 125 mph express trains of Japan. Most tour dates include outstanding seasonal attractions in Japan, such as the spring cherry blossoms and beautiful autumn leaves and some of the greatest annual festivals in the Far East. Total cost is **$1649** from **California, $1828** from **Chicago, $1899** from **New York.** Special rates from other cities. Departures in March, April, June, July, September and October, 1970.

AEGEAN ADVENTURE

21 DAYS $1299

This original itinerary explores in depth the magnificent scenic, cultural and historic attractions of Greece, the Aegean, and Asia Minor—not only the major cities but also the less accessible sites of ancient cities which have figured so prominently in the history of western civilization, complemented by a luxurious cruise to the beautiful islands of the Aegean Sea. Rarely has such an exciting collection of names and places been assembled in a single itinerary—the classical city of **ATHENS;** the Byzantine and Ottoman splendor of **ISTANBUL;** the site of the oracle at **DELPHI;** the sanctuary and stadium at **OLYMPIA,** where the Olympic Games were first begun; the palace of Agamemnon at **MYCENAE;** the ruins of ancient **TROY;** the citadel of **PERGAMUM;** the marble city of **EPHESUS;** the ruins of **SARDIS** in Lydia, where the royal mint of the wealthy Croesus has recently been unearthed; as well as **CORINTH, EPIDAUROS, IZMIR** (Smyrna) the **BOSPORUS** and **DARDENELLES.** The cruise through the beautiful waters of the Aegean will visit such famous islands as **CRETE** with the Palace of Knossos; **RHODES,** noted for its great Crusader castles; the windmills of picturesque **MYKONOS;** the sacred island of **DELOS;** and the charming islands of **PATMOS** and **HYDRA.** Total cost is **$1299** from **New York.** Departures in April, May, July, August, September and October, 1970.

EAST AFRICA

21 DAYS $1649

A luxury "safari" to the great national parks and game reserves of Uganda, Kenya and Tanzania. These offer a unique combination of magnificent wildlife and breathtaking natural scenery: a launch trip on the White Nile through hippo and crocodile to the base of the thundering Murchison Falls and great herds of elephant in **MURCHISON FALLS NATIONAL PARK;** multitudes of lion and other plains game in the famous **SERENGETI PLAINS** and the **MASAI-MARA RESERVE;** the spectacular concentration of animal life in the **NGORONGORO CRATER;** tree-climbing lions around the shores of **LAKE MANYARA;** and the **AMBOSELI RESERVE,** where all types of big game can be photographed against the towering backdrop of snow-clad Mt. Kilimanjaro. Air travel is used where possible, enabling longer stays within the parks. Also seen are the fascinating capital cities of **NAIROBI** and **KAMPALA,** the exotic "spice island" of **ZANZIBAR,** and the historic **MOMBASA,** a beach resort on the Indian Ocean, with its colorful Arab quarter and great 16th century Portuguese fort. Tour dates have been chosen for dry seasons, when game viewing is at its best. The altitude of most areas provides an unusually stimulating climate, with bright days and crisp evenings (frequently around a campfire). Accommodations range from luxury hotels in modern cities to surprisingly comfortable lodges in the national parks (some equipped even with swimming pools). Total cost from **New York** is **$1649.** Departures in July, August, September and December, 1970.

Rates include Jet Air, Deluxe Hotels, Meals, Sightseeing, Transfers, Tips and Taxes. Individual brochures on each tour are available.

For Full Details Contact:

ALUMNI FLIGHTS ABROAD
145 East 49th Street
New York, N.Y. 10017

Class Review

95

We talked with **Luther Conant** who remains the same. He sends his regards to any who remember him.

My best wishes to all for a good 1970.—**Andrew D. Fuller,** Secretary, 1284 Beacon St., Brookline, Mass. 02146

96

The poll of class membership indicates that none of you is in need of the money deposited in the Benevolent Fund. This will be turned over to the Alumni Fund as the 75th reunion gift of the Class in the spring of 1971, as the majority of you have requested.

The sympathy of the Class goes to **William D. Coolidge** whose wife of fifty-four years died last October. When your secretary had a fellowship from General Electric for a summer study program for science teachers, one of the highlights was a talk by your "Dr. Will." At that time, instead of a speech about his researches, we heard an interesting and enlightening talk on the pre-Columbian civilizations of Yucatan which he and Mrs. Coolidge had been investigating on vacation trips. The color slides showed that in his photographic hobby he had utilized his scientific skills, for they were of professional quality. In his Christmas note, he included a news clipping showing him receiving his "pay off" from the insurance company for outliving their tables. The article indicated that he was "one-in-a-million," a fact long known to his '96 classmates.—**Clare Driscoll,** Acting Secretary, 11 Cliff St., Plymouth, Mass. 02360

98

From the trailer: In the last two issues you heard about Mexico. Instead of travelling this time let's reminisce. Among the papers of my father, I read about the Institute being in Boston's Back Bay area. Do you remember the buildings named Rogers and Walker on Boylston Street? They were the hub of your academic life. Rogers was used by the Department of Architecture until 1938. William Rogers was the founder of M.I.T. and General Francis Walker was the third president. The two buildings were approximately the same size. Although lacking the architectural elegance of "Rogers", "Walker" included special rooms for the use of women students provided by funds raised largely through the efforts of Mrs. Robert Richards, '73, who in 1876 was appointed instructor of women.

Before you were Freshmen, these two buildings, together with a gymnasium on Exeter Street and shops on Garrison, were outgrown and a series of buildings was begun on Trinity Place. Remember Engineering A and B? Professor Francis Chandler was the architect of A in 1889 and of B in 1892. Engineering B was planned originally for the Department of Architecture but the latter moved into the Henry Pierce Building (Professor Eleazer Homer, '85, architect) when it was constructed in 1898—the year you graduated. Do send me some news soon.—**Mrs. Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

Copy for this issue of *Technology Review* was due from your Secretary about January 10. News which reached him after that date will appear in the April issue; please note that some news has been held over by the Editors for the April issue.

03

A cheerful letter from our active classmate, Professor Emeritus **Audrey A. Potter,** Course VI, arrived from his office at Purdue University: "Comfortably busy as consultant and writing on engineering research."

Arthur S. Gibbs, Course VI, of Brockton, Mass. writes: "Whenever I lose an old friend I have the same thought. You never know when your own time will come. About the only thing we can do is to take things as they come and try to make the best of them. We really have little to say of the past, so trim our sails to suit the winds as they blow, and, if fortunate, we manage to keep on sailing forward in the right direction."

Another distinguished classmate, **J. Howard Pew,** Course II, is again very prominent in business activity despite his 88 years. In the *Review* of November 1966, Howard came to our attention as the Grand Old Man of the petroleum refining industry. For over 65 years he worked for the Sun Oil Company in Pennsylvania, a company founded by his father, Joseph Pew in 1886. His keen applications to oil refining soon led to the development, with associates, of new processes for producing lubricants from asphalt crude oil.

He was well qualified to assume the Presidency of the Sun Oil Company following the death of his father in 1912 and served in that post until 1947, continuing as chairman of the board until 1963. Thanks to a recent merger into the Sunray D. X. Oil Co., Sun Oil is now the nation's 10th largest oil company with world-wide operations and sales exceeding 1.8 billion a year.

Howard still continues ad libitum in this industry to which he devoted his life though he is now retired; he is still an outspoken critic of government restrictions on business. Howard continues active in Philadelphia affairs, supports conservation projects, and for over 30 years has served as President of the Board of Trustees, General Assembly, Presbyterian Church.—**John J. A. Nolan,** Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143

05

Christmas is not only a wonderful season for family reunions, but also a reunion of many classmates through their postcard messages. Some merely indicated their existence, plus a happy salutation, such as **Carl** and Anne **Atwood,** Ione and **Arthur Balkam,** Anna and **Robert Adams, Charlie Mayer, Gil Joslin** (from his Florida hotel), Isabella and **Chet Shaw, Walter Eichler, Pat Sullivan, Sam Seaver,** and Helen and **Dean Klahr** (with their pictures, in a Christmas setting). If there were others, please forgive, as Hobby Knob was never in such a state of turmoil as this year.

Herb Bailey's Christmas letter was a won-

derful family message and contained this which I am sure you will be interested in: "The Edgar Baileys are now reduced to four at home, since the eldest, Kathie, is married and Mary and Herbert are in college most of the time. Edgar had to go back to Turkey again this summer to direct the course in field geology he set up several years ago under CENTO. . . . As for me I'm sort of 'housebound' with no driver's license and too lazy to walk very far. Reading, enjoying color TV, writing letters, my stamp collection, and last, but not least, my pipes keep me amused. How true it is 'that it's better to smoke here than hereafter.' "

Alice and **Bill Spalding** say, "Our family in Norfolk are excited over the wedding next week of our oldest grandchild, Susan Hollis, and of a grandson in February. We really are getting along—when our crop of grandchildren (10) start married life!"

Peggy and **Bill Ball** are apparently and happily settled in their new home in Bradenton, Fla. In their friendly Christmas letter Peg says, "We find ourselves, this Christmas, in a modest house in a semi-tropical setting and in a quiet neighborhood with all necessary facilities. We call it 'Sweethome,' which is the way we thought of our Cotuit home. Events have moved swiftly since last June when we slept here on army cots until our furniture arrived on the fifth. (Army cots *look* comfortable but that is all!) Our close neighbors, whom we now call our friends, have been wonderful to us."

Grace and **Roy Allen** report on some of their 1969 doings, but do not sign up (yet) for our 65th reunion next June. "No news with us; we both are well, but age is creeping up and we lack much of the vim and vigor. Have stayed home this year except for a trip to California in the spring, and one to the high country last month, where the aspens above an elevation of over 8,000 ft. were the most gorgeous we have ever seen. Colors of other deciduous trees here are for the most part dull yellows and browns. We had hoped to go east this summer but did not feel up to it. Find that after a 200-mile trip we are ready to rest for a day. Maybe next spring we will have more ambition."

Hal Robbins' card shows a scene of 200 acres "where we live" with huge Arizona mountains in the background. By microscope I have spotted Orangewood Apartment, where Roy and Grace Allen also live. I hope to see it sometime.

Herman Eisele says, "How am I doing? I am still rambling around in the same apartment where Mama and I lived for 15 years. I have a good housekeeper who comes, two days per week, to take care of those household chores for which I never had an affection or talent. I still go, by bus, to my office in the Engineers Bldg. five days a week where I do a little professional work and take care of numerous personal matters. At 87, I have many limitations, but my health is still fairly good, thanks to the careful supervision and control of eight medical specialists whom I visit at regular intervals."

There are still a few '05ers who "visit their offices regularly" (or less often), and we admire their physical endurance and stick-to-it-iveness. However, the prize for physical activity still goes to **Errett Graham.** In reply to a birthday card greeting I had sent him, he corrects my statement that **Bob McLean** is our oldest classmate. Errett says that if he lives until June 8, 1970, he will be 93 years old. How's that for a fellow, who only two years ago was paddling his canoe around an island in the Pacific Ocean. And he expects to do it again this summer, if not in the Pacific Ocean, in Puget Sound. He might be coming to our 65th reunion, via the Panama Canal.

There are a few more messages, which I shall withhold for interpretation and future reporting. Please **Gilbert Tower** and **Robert Beard** have a bit of patience, and I'll get you into the April issue. The **Charles Smart**s also. **Tom Geraghty** says, "Am 87, in excellent health—wife 79—married 55 years—one son—5 grandchildren—very active."

Lloyd Buell writes that his wife Eleanor died on December 4, 1969. They had been married for fifty-five years. I wrote feeling that I could express the sincere sympathy of the Class.—**Fred W. Goldthwait,** Secretary, Box 32, Center Sandwich, N.H. 03227; **William G. Ball,** Assistant Secretary, 6311 Fordham Plaza, Bay Shore Gardens, Bradenton, Fla. 33505

08

The alumni records report the death of Professor **John Tyler** on June 14, 1969. Knowing nothing of the situation I wrote Annapolis for an obituary. Mrs. Tyler returned a copy of her husband's obituary for which I thanked her and I expressed the deepest sympathy of the Class.

Professor John Tyler, grandson of the 10th President of the U.S., died at Anne Arundel General Hospital at the age of 82. He was born in Williamsburg, Va., son of the late Dr. Lyon Gardner and Anne (Tucker) Tyler. He lived at 3 Southgate Ave., Annapolis, Md. Professor Tyler graduated from M.I.T. as an electrical engineer and later became Professor of Mathematics at the Naval Academy from 1916 until his retirement in 1952.

Surviving are his wife Mrs. Elizabeth Parker Tyler; two daughters Miss Betty P. Tyler of Annapolis and Mrs. Clay H. Raney of Little Rock, Ark.; five grandchildren and two great-grandchildren; and a sister Mrs. Alfred H. Miles of Charlottesville, Va.

One beautiful afternoon in November an old friend **Carl H. Bangs** and wife called on us at our winter home on Casey Key, Florida. They were riding with Mr. and Mrs. Crook all from Rome, Ga.,

Carl H. Bangs, '08

and were visiting sunny Florida. I hadn't seen Carl since we worked at the Boston Edison Co. back in the early 20's although I had written to him. Carl hadn't changed much although we are all getting along. Talking of old times was very pleasant. He has since written me telling what he has been doing the last 60 years.

The first 20 were spent getting experience, rolling around like the proverbial stone that gathers no moss, but gets a pretty good polish. After being associated with Lockwood Green of Boston engineers Carl signed up with the American Chatillon Corp. for whom these engineers were designing a new synthetic fiber plant for Rome, Ga. American capitol built the plant to produce both acetate and viscose yarns but the "know-how" and fundamental design was obtained from the Soie de Chatillon, Milan, Italy, the leading synthetic yarn manufacturers in Italy. They had developed a new process for making acetate of cellulose fiber. Eastman (Kodak) was interested in acquiring the process that was later perfected at Rome. This acetylation process did not grow as fast as the viscose division that carried the load until merger with the Celanese Corp. in the mid-40's. Carl went to Rome in December 1928 and from then to December 1954, he was associated with fiber plants, in an engineering capacity, serving several reorganizations until he retired in 1954. Carl was Plant Engineer for the Rome Plant of the Celanese Corp. of America. His hobby is driving around the country up and down the coast, summering in New England and wintering in Florida.

Herbert C. Elton of Munger Lane, Bethlehem, Conn., a civil engineering graduate writes that he is continuing the practice of architecture and engineering with research in materials and methods.

John R. Reyburn of Hyannisport, Mass., a mechanical engineering graduate, has retired. He writes, "Growing older like the rest of '08," and gives his new address as 117 Junius St., Thomasville, Ga. 31792.

Arthur T. Hinckley, who received a master's in chemistry with us, writes that after running around for 50 years looking at electric furnaces and locating suitable ore to feed them, he has retired to gardening in the summer and making orchids bloom in the house in winter.

Another change of address is that of **William H. Medlicott** from Fuller St., Newton to South Vine St., Urbana, Ill. 61801.—**Joseph W. Wattles,** Acting Secretary, 1508 Casey Key Rd., Nocomis, Fla. 33555

09

In the February *Review* we reported the accident to **Art Shaw** resulting from his falling from a ladder while pruning a tree at his home in Auburndale. We have received the following letter from him from his Florida residence, Longboat Key, dated December 31, 1969: "I am glad to announce my safe arrival in Florida on December 9. My body cast was removed November 24 and after a trial period walking around without support, I got my doctors' consent to motoring to the sunny south, though they would have preferred me to fly. Our elder son Dick (Class of '35) and his wife Barbara accompanied us and he did the driving. It proved to be a comfortable trip both for me and for Barbara who had left the hospital only a few weeks before. My back continues to improve. I have played a little shuffleboard without discomfort. I haven't tried bathing in the Gulf and probably will not except when it is quite calm. My orthopedic surgeon approves of the heated swimming pool as good therapy but jokingly draws the line at 'diving from the high board!' I think Betty is getting rested from the care and anxiety which my accident caused her and we both look forward to being our old selves when we return to Auburndale next May." The Class wishes Art continued and rapid improvement with the assistance of the Florida climate.

It is with much regret that we report the death on November 30 in Wenham, Mass., of Marcia Wallis, wife of **George Wallis,** our Assistant Secretary. We have reported earlier that failing health had recently prevented her from attending Alumni Day activities with George as she so consistently did before ill health overtook her. Marcia was born in Wenham and lived there the greater part of her life in a home that had been in the family for many years. She was a graduate of Wheelock College and before her marriage taught kindergarten in Marblehead. She was a member of the First Church, The Improvement Society, and the Historical Society. Besides her husband she leaves two daughters, (Elizabeth) Mrs. Albert W. Dodge of Wenham and (Frances) Mrs. Addison Sanford of Wayland; five grandchildren; and six great-grandchildren.

We wrote to George expressing the sympathy of the Class as well as our own. Mrs. Dodge, whose home is adjacent to her father's, replied enclosing a clipping and stating that George would like to write but at the time did not feel up to it. The family requested that flowers be omitted and donations in Marcia's memory be made instead to the First Church. In behalf of the Class we have sent such a donation and Mrs. Dodge sent us the following note: "Would you please convey our deep appreciation to the Class of 1909 M.I.T. for the contribution to the First Church in Wenham in memory of my mother, Marcia Wallis. Because of failing eyesight my father is unable to write at this time but he wishes me to thank the Class of 1909 for its most thoughtful expression of sympathy."

The Alumni Office received a note from **Harold Paine** stating that he was at M.I.T. only two years having first graduated from Brown University. However, he was captain of the varsity hockey team and also received a Tech degree. Our records show that his present address is Miami, Fla.

Edward Chapman, Course III, has also sent a note: "Age 83 years. Eyes bad. Memory also bad. Can't do much reading and mostly with magnifying glass. Have bought in Wade Park Manor (Cleveland, Ohio) for rest of my life. My oldest son lives in Vancouver, B.C., Canada. Next son in Los Angeles with wife and daughter. My youngest son, wife and four children in Bethesda, Md."—**Chester L. Dawes,** Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138; **George Wallis,** Assistant Secretary, Wenham, Mass.

1970 Alumni Fund

as of

January 27, 1970

Class	Donors	Per Cent	Dollars
1900 (through)	12	31	$1,290
1901	2	15	1,025
1902	4	19	235
1903	10	32	705
1904	14	42	1,049
1905	17	39	3,355
1906	18	30	535
1907	21	38	1,222
1908	30	42	5,103
1909	36	44	29,535
1910	25	31	1,933

10

Notices from members of the Class have been very few this past month. However, I have heard from **Carl Sittinger.** His wife writes as follows: "Carl's health has been none too good the last two or three years. During this past year he has been in the Deaconess Hospital twice and the Peterborough Hospital once. All this is due to hardening of the arteries and poor circulation causing occasional blackouts and falls. I know he has had your letter on his desk for months, but has lacked the energy to write you personally as he has wished." I hope Carl will be in better condition to attend the 60th reunion in June.

John Bierer's wife writes as follows. "John has been ill since last January." We also send our wishes that John will be in better health so that he too will be able to attend the reunion.

James Tripp sent us a short note as follows. "I am enjoying prospect of attending our 60th reunion next June. Also having a bunch of successful descendants, a son and 4 grandchildren."

Allen Gould also is hoping to be present. "Am still hoping to be present at our Sixtieth Class Reunion next June." I had a card from **Carl Lovejoy** also hoping to see us all in June.

It appears we will have a good attendance at the 60th.—**Herbert S. Cleverdon,** Secretary, 112 Shawmut Ave., Boston, Mass. 02118

11

This month's notes are the condensed (with his permission) memoirs of **Harry Tisdale** of Ft. Meyers Beach, Fla. Harry graduated in 1909 from Rhode Island State College entering M.I.T. in his junior year. For some years he had been spending his vacations working in the various departments of the Brainard and Armstrong silk dyehouse in New London where his father was superintendent. On expressing a wish to follow in his father's foot steps, Harry was advised by Dr. Emil Lesser, chief chemist for the American Dyewood Co., to get some experience in Europe, particularly in the silk center at Grefeld, Germany. Mr. Armstrong of the dyehouse thought the idea so good that he gave Harry a contract to work in the dyehouse for one year after graduation at $20.00 a week, then two years in Europe still at $20.00 a week. On his return he would spend another two years in the dyehouse at $40.00 a week of which $20.00 would go to repay the money advanced while Harry was in Europe.

Harry Tisdale, '11

After some sight seeing Harry arrived at Leipzig where he signed up for a course in chemistry in order to master the German language. While waiting for the university to open he acquired a tutor and started plugging on the language. During this period, Harry spent some time in Wernigerode where he met a friend from Boston, took long walks in the mountians and continued plugging on his German. By October when the University opened, Harry had become proficient in German and spent one semester in the laboratory trying to treat dyed silk skeins so they would resist taking on more color when cross dyed as woolen piece goods.

In January, Harry left Leipzig for Grefeld where, through the head master of the dying school, he met Herr Brocking, one of the owners of a silk dyehouse. After some dickering Harry agreed to pay 100 marks a month for the privilege of learning and went to work the next day. The work was similar to that which he had done in New London. The boss would give him a bundle of silk skeins and a sample to be matched. He would make up the necessary dye bath and add the colors needed to match the sample. He would then take a sample dying to the boss who would either OK it or suggest some additions for a closer match. Harry spent five months in this dyehouse working in the boil off department, the color department, the black shop and the tin shop where the silk went through various tin, phosphate and silicate baths to increase its weight. While working in the black shop, Harry paid one of the older workers who had been in the black shop 20 years to go to his house evenings and talk shop. This was important as he told him how to keep out of trouble and more important how to get out of trouble when something went wrong. In New London they had a black shop with 18 or 20 men working full-time. As silk batches ran about 400 pounds, worth about $8000.00, mistakes could be costly. As he was doing the same work as the other dyers, Harry eventually did not have to pay the 100 mark a month fee, a break for him.

After he quit, Harry packed his bags, shipped them to Trieberg on the Swiss border, and then started walking there. It was about 80 miles and he made it in 5 days stopping at rest homes for lunches and lodging at night (75¢ for bed and breakfast). From there he went to Lyons by train and secured a room in a pension. The American Vice-Consul introduced Harry to a member of the firm of Christoph Pere and Fils who ran a silk piece dyehouse. Here Harry did work similar to the work at Grefeld again without pay, except it was on piece goods instead of skeins. From Lyons, Harry went to Frankfurt where he spent a month in the laboratory of Casella Color Co., and while in Germany he was able to visit several dyestuff manufacturers.

After finishing in Frankfurt, Harry visited friends he had made in Nurenburg and Leipzig and then went on to London at which point funds were getting low. The necessary $250.00 came through by cable and Harry came home by way of Montreal and Boston arriving home just two years to the day from the time he left. He went back to work in the dyehouse under his father, finished the last two years of his contract, and made another five year contract for $50.00 a week plus 5 per cent of the profits of the dyehouse of which he took full charge. The 5 per cent profit was based on the difference in cost between having the work done in the dyehouse and having it done outside; this doubled Harry's pay.

The war in Europe came three months after Harry's return and, as he had foreseen the shortage of dyestuffs that would result, he laid in all he could get including logwood, hematine, fustic, hypernic and osage orange. The company had government orders for silk thread, black for the navy and olive drab for the army, and he was able to get them out using the dyestuffs on hand. At the end of his five years, Harry left, leaving his assistant to take his place.

Harry married Grace Holliday on July 14, 1917 and had several months off before taking a position as salesman for the American Dyewood Co. of New York. He spent some time in Chester Pa., at the laboratory and factory before locating in Schenectady, the best location from which to cover the trade in New York state. He was interested in selling the natural dyewoods to the leather, wool, cotton and ivory button trades. He even had one customer who used logwood to color steel hammer heads; the Winchester and Remington arms companies used logwood for bluing the steel in rifles. Harry had a sudden call from his boss to find out if he could dye black with logwood that would stand boiling in a soap solution. He could and was sent to see the Coates thread company which was advertising a boil proof thread and was having trouble with chrome black. The black dyed with logwood was deeper and fuller than that obtained with chrome black.

After 11 years of covering New York State customers, Harry was called to New York City as sales manager in 1932. After three years in an apartment within walking distance of his office, Harry and his wife moved to Scarsdale to be near Rose and **Joe Harrington,** so, he became a commuter. In 1942 Harry was elected chairman of the New York Section of the American Association of Chemists and Colorists. In 1944 he was elected Vice President of the American Dyewood Co. where his practical experience in the dyehouse proved profitable. A midwestern woolen company was having trouble with their logwood and threatened to change over to chrome black. So Harry took a sleeper that night and arrived at the dyehouse the next morning. He had them load the machine with 500 pounds of wool, put it through the regular dying process and then dump it on the floor. The wool was full of undyed spots. Harry had them reload the machine and carry through the process again with only a small amount of dye and then after rinsing, drop the load back on the floor. There were no white spots. The trouble was known as occluded air in the very dry wool. No dye could reach some areas which accounted for the white spots. When the air pockets were broken up the dye could get in and everything went as expected. Harry went back to his office with an order for 20 bbls. of logwood.

During 1948 the American Dyewood Co., which had been founded in Greenwich Village in 1798, celebrated its 150th anniversary and published a book, *The Tale of Two Trees* giving the history of the logwood industry and that of quebracho extract, a tannin material from the Argentine.

By this time Harry had been elected director of the United Dyewood Co. The American Dyewood Co. with branch offices in Philadelphia, Chicago and Boston, suffered a serious setback with the advent of synthetic materials and artificial leather which made a dent in the sales of tannin materials. New fibers such as nylon and acetates cut into the silk business. Logwood could be used to dye black on all these fibers but could not compete with analine dyes for colors. So there was trouble brewing.

In 1950 a new group took over control of the United Dyewood Co. and proceeded to sell off all the old subsidiary companies and buy new ones. Harry, being the only one left with a knowledge of the dyewood business was made Executive Vice-President of the American Dyewood Co. and its office was moved to Belleville, N.J. forcing Harry to drive back and forth from Scarsdale every day. In 1953 the company forced everyone over 65 to resign and in 1958 the American Dyewood Co. was sold and all pensions stopped.

So in 1954 the Tisdales sold their house in Scarsdale and moved to Waterford, Conn. In 1957 they again moved, this

time to Ft. Meyers Beach, Fla. where they had some close friends. In June, 1961, the Tisdales drove up to New London, then went on to attend the 50th class reunion at Snow Inn on the Cape. In 1962 some X-ray pictures showed that Grace had bone cancer. They went to the University Hospital at Gainsville for a check up but an operation was not advised. Grace passed away in February, 1966, just one year short of their golden wedding anniversary.

Harry has served for two years as deacon of the Chapel by the Sea and treasurer of the local chapter of the National A.A.R.P. He notes that he has been getting plenty of exercise the past few years cutting nearby lawns and is feeling fine.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

DO YOU REMEMBER the compulsory military science course in our freshman year, which none of us liked, though Major Wheeler did his best to make it interesting. I recall an exam question, "What would you do with a campfire on breaking camp?" to which one unfortunate replied, "Hang it on a tree!" This facetiousness resulted in a failure mark and a repeat course the following year. Wonder how it would be handled today?

Fritz Shepard writes that his eyes are continuing to improve after his double cataract operation. The rheumatoid arthritis, however, has kept him from travelling about to any extent, though he is continuing his daily walks. He and Betty spent the summer as usual in Marblehead. There are nine grandchildren, six in college and three in boarding school, with whom they keep in touch, necessitating a good deal of letter writing. The older ones attend six different colleges: Harvard, Colby, Cornell, Ithaca, Western and Washington University. Betty is well and keeps busy with various activities; she is a corporation member at Simmons.

We have a refreshing letter from **John Hall,** Course XI, who lives in Allenhurst, N.J. He claims to have been the "rolling-est stone" in the Class, having had so many jobs he can count them instead of sheep, to put himself to sleep. His estimate is about 40, including those for community and civic affairs. We quote, "I probably should be ashamed of such a record, but I'm not. I have enjoyed rattling around, and sometimes quit just because I was bored. To the best of my memory, I was never fired. My training in sanitary engineering was little used, although in 1912 and even more today, it has been one of the most important things needed by this country. I did spend the last four years of my career with the New Jersey State Department of Health, the fourth time I had worked with them. But I have not been alone in my neglect of our specialty. **Bucky Freeman** went to Brockton to make shoes; **Bill Collins** has been building excellent highways for the State of New York. On the other hand **Francis Kingsbury,** who started with me in the Massachusetts State Health Department in 1912, retired from this same organization after 47 years of service, as head of all their water supply activities. Then there was Harry Ferguson, who died too young, while with the Illinois Health Department. He was a good fellow, and one of my best friends.

"I did get into various other activities of public health, was Health Officer of two New Jersey cities, and made a sanitary survey for the Province of New Brunswick, now known as 'planning.' In the forties I publicized an anti-VD program. During World War II I was a public health engineer, both in Las Vegas and in Alaska. I also served as a field man with military connections in the American Social Health Association, and there were many more. I believe that we early health men did our work too well in some respects. As a result we practically cleaned up the dangers of small pox, typhoid, diphtheria, scarlet fever and polio. However, greater problems are now with us as a result, too many people and too long a life span. It is people, not nature, that bring about accidents, alcohol, drug problems and cigarettes, as well as air, water and land pollution.

"As a suggestion for class news contributors, possibly our letters would be more interesting if we could read about some *real* 'accomplishments' during our careers, such as strokes of dumb luck, hazards survived, or perhaps some amusing incidents. I have often amused myself by lining up cause and effect, using incidents in my personal experience—one of the advantages of growing old. Sometimes this is a joy and pleasurable, but it can bring sorrow. For example, in my days at Tech the only course I flunked was military science under Major Wheeler. A few years later, however, I became a Captain in the army. I was extremely poor in Arlo Bates' English course, although I have always enjoyed reading, but during my career I secured pay raises in many different jobs involving writing. I was good in math, but today I have trouble balancing my check stubs, and use a slide rule only as a straight edge. And so it goes! But age does have its advantages, such as the smug satisfaction of believing that you can do nothing now about the troubles that beset the world. Then, if you are mentally sound, have a moderate amount of health, and freedom from financial worries, you see many things you *don't* want. You have travelled so much and done so many things that they no longer interest you. You are now glad that certain friends and acquaintances are far away. After this effusion, you may decide that I am a long-winded, jolly old codger with a cock-eyed philosophy. And you will probably be correct!"

A note from **John Barry,** Cohasset, Mass., says, "I have no earth-shaking news to report, except that another birthday has come and gone. My wife and I had a fascinating three-week trip last spring to the Greek mainland and the Aegean Islands; otherwise we have been pretty much at home although I spent 12 days in the hospital with pneumonia. I have no current news regarding other classmates. It seems a pity that a bunch of long-haired bums were allowed to take over the Administration Building at M.I.T. More power to you in a thankless job!"

From **Wallace Murray,** Course X, "After I returned from Africa last April, I spent a few days with my daughter in Hackensack, N.J. Then in June, I flew to Zurich with my son and family where he had a business appointment. We had fun visiting Luzerne, Geneva, Rome, Paris and London. The rest of the summer, I was with my son at Sebago Lake Maine. The doctor tells me I am in perfect health, so I plan to leave for a trip to Antarctica in February. I shall stop at Patagonia on the return trip. I will write and tell you of my experiences which should be interesting, and it is unlikely that many of our Class have visited this part of the world."

Although we always see **Bill Collins** each year at Alumni Day, he has not replied to our repeated requests for a contribution. We are accordingly including the following information obtained by phone. On graduation Bill accepted an invitation to work in the Civil Engineering Department under Professor Dwight Porter. He soon moved to Hornell, N.Y., where he established connections with the N.Y. State Department of Public Works. At the beginning of World War I, he accepted the assignment of construction at Camp Devens, Mass., Fort Meade, Md. and the Franklin Tank School, Md. He was in charge of building construction at these facilities. When peace returned, he moved back to Hornell as a highway contractor, and has built many of the state highways in the vicinity. He is still engaged in this work. In 1917, he married Pauline Acher, and has one daughter. Bill says Pauline has taken good care of him for many years, as evidenced by his good health. There are two grandchildren. His son-in-law is an attorney and acts as his lawyer in the business, an excellent combination.

On his 84th birthday, **Dave Guy** lapses into poetry with the old class spirit, thusly:"

"Greetings to all as we add to tomorrows
And to our life's span more credits we'll borrow.
With '70 we'll start a new orbit of Sol
And travel through space like the astronauts all.
The jolly old moon will still orbit around
Now our glorious flag has been placed on its ground.
And when this adventure is happily done,
Let's do it again in '71.
And should God be willing that you all

live through
We'll meet at our Sixtieth in '72. . . .
Happy New Year."

Jim Cook writes that he is still struggling along, though with one leg shorter than the other, due to his auto accident, and with his hearing increasingly below par. He claims to be "a battered and deaf old guy, who can no longer even fish successfully." He quotes from Arnold Gringrich in *The Well Tempered Fisherman* who writes of fishing in Iceland with native sportsmen. "They use sturdy rods and drink round after round of toasts from pocketed bottles initially full of local firewater." Our best wishes, Jim! You may be down but far from out so long as you retain that wonderful sense of humor.

John (Bucky) **Freeman,** Course VI, of West Palm Beach, Fla., died suddenly on November 24, 1969 at the age of 82, presumably from heart failure. We saw him in Cambridge on Alumni Day, at which time he and his wife, Avesia, had driven north for a New England vacation. Bucky retired to Florida from Jamaica, N.Y. some 15 years ago. For many years he was associated with the American Tel. & Tel. in New York. He is survived by his wife, one son, one daughter and three grandchildren.

We have also learned belatedly that **Paul Fraser,** who was with us for but two years in Course I, died on June 20, 1969 in his home town of Sellersville, Pa., where he worked with the U.S. Gauge Co. many years until he retired in 1955. He soon returned to work as engineer for the State Department of Highways again retiring in 1965. He lost his wife several years ago. He had one married daughter who lives in Cologne, Germany. There are two grandchildren.—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081; **Jay H. Pratt,** Assistant Secretary, 937 Fair Oaks Ave., Oak Park, Ill. 60302

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When you read these notes, winter should be on the wane; local politics will be in full swing. We hope you all had a Merry Christmas and a Happy New Year; we did. A number of Christmas cards were received by the Capens: from the Frank Achards; the Prescott Kellys; the Allen Brewers; R. Charles Thompson; the Ellis Brewsters; Gordan G. Howie; the William R. Mattsons; the Frank Pillmans (Janet Mattson); Mrs. Lester C. Gustin; the Irving McDaniels (Class of 1916)—we thank you very much. We are very appreciative of the response (90 plus) to our annual plea for yearly dues and questionnaires from our potential of 250 members. The opinions we received were gratifying and a summary was forwarded to the *Technology Review*; it appeared in last month's issue. We of the Class of 1913 should be pleased by how splendidly President Howard Johnson and his several committees have handled the M.I.T. community.

Phil Burt writes, "Dear Phil, I guess I got Harry Burnham's bill and he probably got mine. However, here are my two bucks. You do a wonderful job on the class notes in the *Review,* and although I do not get into the class activities, I really enjoy reading the *Review.* Keep up the good work and the best of luck to you."

Hilding Carlson reports, "Hi Phil, Hope you and your lovely wife are feeling in the pink. We have spent the summer in Milton, N.H. as usual, and it was a delightful interlude between snow storms. All of our 13 grandchildren visited us except one who is stationed in Iceland with the navy, and another who is with the navy in Vietnam.

"It seems that at this time in life I should have been immune to blandishments, but when the President of B.U. wrote me that the trustees wanted to give me an honorary degree, what could I say? So after tomorrow, kindly address my mail to Dr. Carlson. I'm only kidding. I still like the title of Mr." Congratulations Doctor; well deserved.

Allan Waite informs us: "Dear George, I am still at the old stand—hanging on after a 'doze call' at Peter Bent Hospital. I'm O.K. Now. Drop in." Glad you are back in good health again.

Johnny Welch always furnishes us with very interesting news, and we quote: "Dear Phil, Here is the $2.00—now please don't spend it recklessly! It's nice to see your name still on the Tech affairs. I was looking through the old Tech Year Book with my grandson and showing him that illustration group of the prom committee; a very good group confidentially. Billy thought so. I read of your various activities and it is so wonderful that you keep at it; and you have always done a good job for '13. . . . Frances and I are both well. We go to Florida every year now for March and April. We play a little golf, swim, etc. Best to you and your wife. Johnny."

Robert Tullar states: "We just celebrated our 50th wedding anniversary. Both are still mobile. Regards, Bob."

Kenneth Blake is still a loyal member of our Class. He writes: "Hello Phil, Just to show that my heart is in the right place, I am paying last year's assessment, which I was just too lazy to attend to. Do appreciate your work as secretary and always look first in the *Review* for the class notes. We enjoy this Washington location as we are fond of camping and get out often in a tent trailer in the high Cascade Mountains. We have fine seashore spots, too; but have always preferred the majesty of the mountains. My regards to any of the Class you may happen to see or talk to. Sincerely, Ken."

George Bakeman and his nice wife should be congratulated. We quote. "Dear Phil, All still goes well here at the 'Oaks.' We have lived through our 50th wedding anniversary and my 80th birthday without even a flat tire. Cheery-O, George."

Fred Lane reports, "Hello Phil, nothing too exciting to report. Eva and I have just returned from a drive to Florida where we renewed many retired acquaintances and saw some relatives. We covered a good part of the state and enjoyed the trip thoroughly, despite persistent showers. We sometimes wonder if we will still be able to drive to our 60th. Best regards, Phil. Fred."

Brief Notes
George Wallace, "Hi Cap"; **Burton Cushing,** "Hi, Phil"; **George Dempsey,** "Regards, Phil"; **Walter Muther,** "Merry Christmas to all"; **Warren Gentner** states, "Hope you are keeping well and fit."; **Benjamin F. Thomas,** "Phil and Mrs. Phil, Merry Christmas"; **Allison Butts,** "Best regards"; **Charlotte Sage,** "Hi yourself, and best of luck"; **Bill Mattson** always writes interesting letters and we quote in part, "When are you and Roz coming to Denver? Here is my check for $2.00—glad you didn't raise our class dues! Everything else is going up!" Thanks, Bill. Maybe in 1970 you may see us travel; the low priced dues are sufficient until our 60th in 1973. **Geoffrey Rollason** adds, "Regards to Phil and Roz from the Rollasons"; **Dave Stern** notes, "Hi, Phil. Fond regards, Dave." **Joe Cohen** remarks "Hi, Phil, Yours is a thankless job. God bless you." **Jack Farwell** writes; "Hello Phil; am a little late on this due to my followup. You are doing a fine job in *Tech Review.* Best to Roz, Jack"; **Raymond Haynes** adds, "Hope you and Mrs. Capen are well. Best regards. Ray."

We secretaries are working together for our Alma Mater for 1970 Homecoming. A letter has been received from A. L. Bruneau, Jr., Secretary of the Class of 1938, and also a member of M.I.T.'s Alumni Day Committee. "Fellow Class Secretary: M.I.T. HOMECOMING, June 14-15 Sunday is the Game. Remember the POPS? Arthur Fiedler, the pink champagne, the tables in Symphony Hall?

"The Hall is booked for M.I.T. on June 14. Only problem: There are only 1,186 table seats on the main floor. Present plans are to give preference to the 50, 40, and 25 year reunion classes. After that, by classes on a first-come, first-seated basis.

"The message is quite clear: Your personal prods via class notes and individual contacts will get your class a block of tables—if your classmates will respond promptly; late registration gets the balcony. I'm pulling all the stops to get out 1938; I suggest you push in class notes and any other way you can for your class."

It is with a heavy heart that we must announce the passing of our classmate **Walter L. Whitehead.** We quote the letter received from President Howard W. Johnson. "I regret to inform you of the death of Professor Walter Lucius White-

head, Associate Professor of Geology, Emeritus. Dr. Whitehead, who was 78 years old, died following a lengthy illness on Tuesday, December 2, in Cambridge, Massachusetts.

"Dr. Whitehead is survived by his sister Florence Whitehead of Cambridge, and by his brother, Gilbert Whitehead of Tucson, Arizona. The family requested that in place of flowers contributions be made to the Walter L. Whitehead Fund at M.I.T. Howard W. Johnson."

It is our duty to report the death of **James M. Beale,** 436 S. Nokomis Ave., Venice, Fla. 33595, and we give you the contents of a letter from Mrs. Beale. "Dear Mr. Capen, My husband, James M. Beale, died in the Venice Hospital on November 18, 1969. He had been failing for a number of years and it is a great blessing he passed away when he did; as he would have had to spend the rest of his days in a nursing home upon his release from the hospital. Sincerely, Mrs. James M. Beale." We have already advised Mrs. Beale of our grief, personally, as well as, for the Class. Our sympathy has been extended to our classmate **Stuart Eynon** and family on the passing of Mrs. Stuart J. Eynon (Ellen) on December 5, 1969. She and Stu attended several of our reunions. We shall miss her.

Can anyone furnish us with the proper or latest address of **Leon M. Hecht,** formerly of 3943 Westlawn Drive, Nashville, Tenn. 37205?

Changes of Address: **Gilbert R. Pardey,** 333 Grand Ave., Englewood, N.J. 07631; **Halsey Elwell,** 333 Boundary, Aiken, S.C. 29801. Until next month.—**George Philip Capen,** Secretary and Treasurer, 60 Everett St., Canton, Mass. 02021

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The Florida contingent was increased beginning December 27, 1969 by the **Harold Richmond**s. Their note says they would spend three months at Del Ray Beach.

We are fortunate to have **Les Hamilton** in our official class family for Ham is especially close to the Institute and can often supply better information on the student confrontations and irregularities than are reported in the press. It seems that as this is written in January, 1970, things have settled down. Such activities that have occurred have apparently been largely inspired by the military contracts which M.I.T. has carried on for many years. The racial situation has not been a factor. M.I.T. has encouraged admission of a larger number of colored students for some time, and there is going on during the summer a preparatory course to help them pass the exams and otherwise increase their number.

The notes were written during the Christmas season when we received cards from many of you for which we are duly thankful. Perhaps the most interesting was from **Hib Busby** in Texas, a photographic reproduction of a grouping of several hundred shells which are indigenous to his neighborhood. These shells outline a decorated Christmas tree.

Thorn Dickinson sends an interesting photo, presumably taken at his hideout in the Adirondack region of New York. It shows a high peak in the mountains and he challenges me to match it in Maine. Well, we have some nice rolling country in view near us and it is not too long a drive to Maine's Mt. Katahdin. We'll have to get together with him to swap terrain claims.

Here's a note from **Walter P. Keith** in which Walt expressed his regrets at having missed our 55th reunion and regards to all '14ers. In telling of his immediate past history he writes, "As founder (in 1930) principal stock holder and chairman of the Hygienic Dental Manufacturing Co. I am, of course, my own employer. My son, W.D.K., Jr., '41, joined our company in 1952 following military service in W.W.II and Korean War. He is now president of our company. Our three grandchildren include W.P.K. III, a freshman at Hobart. My wife, Fama, and I celebrated our 50th wedding anniversary in August 1968 and are both well and active. (Incidently we note that W.D.K., Jr. and our son H.A.A., Jr. were classmates in M.I.T. 1941.)

Ham has a few notes on his Christmas card: "Hi: You really did a job on the December issue. As a result of Alden's letter we may call on Chisham when we go to Nashua. Our daughter lives there and is very active in raising money for the new art center which will need 1½ million and has a million mostly donated by big business in that area. Our ground is not frozen yet; we are constantly threatened with snow 40 percent which turns out to be rain 10 percent. The river has not skimmed over yet, our S.D.S. is slowly folding up or perhaps performing at Harvard and B.U. There is more outdoors to run in at Harvard—our corridors are 8 feet wide and we are 99 percent good guys who want to study. Hope you can send us a few freshmen next year. Have fun."

Frank Atwood's card notes that his area is now being worked over again in the behind-the-scenes Kennedy Inquest.

We are reminded by Al Bruneau '38, who is chairman of the Alumni Day Committee not to forget the affair—M.I.T. Homecoming, June 14-15. The Symphony Hall has a limited capacity, tables are reserved. We have generally had at least one table. So think it over and get your bid in early.

And in signing off this edition of the notes, in answer to your questions, I am delighted to tell you that my last eye operation some weeks ago was a complete success and I now have essentially 20-20 binocular vision.—**Herman A. Affel,** Secretary, Rome, Maine. Post Office: RFD, 2, Oakland, Maine 04963

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The deep sympathy of our Class goes out to 1917 in the sad loss of their Secretary, Dix Proctor, who died December 13 at Lincoln Park, N.J. and to 1927 in the death of Glen Jackson, who died December 26 at Amherst, N.H. Both these men were active in class and alumni work and will be sorely missed. They were both good, old friends of Fran's and mine and whenever they were in Boston they always visited us.

Donald deFremery died November 12, 1969 in Portala Valley, Calif. Besides his wife Helen, he leaves seven nieces and two nephews.

Plans for our 55th reunion will follow the same as for our 50th. We'll meet in our Class headquarters room at M.I.T. from noon to two o'clock on Friday, June 12 to drive to Coonamessett Inn at Falmouth, Mass. It will be Room 7-102, straight ahead thru the main M.I.T. entrance at 77 Massachusetts Ave., Cambridge. At Coonamessett we'll follow our usual informal program, with a banquet Saturday night at the Inn and a real New England shore dinner at Poppanessett Inn on Sunday—everything from clams to clams!

Returning to Boston immediately after that, we'll be able to attend M.I.T. night at the Boston Pops in Symphony Hall. This will be a really good show. Then, on Monday, Alumni Day, we'll have our Annual Class Cocktail Party and Dinner (in one place) at the M.I.T. Faculty Club, followed by a finale of cordials at Bill Smith's apartment—a grand time for every one. Plan on it! Barbara Thomas, our gracious and congenial hostess will be on hand to greet you all at the cocktail party. Classmates from a distance may go directly to the Inn. When you receive our final notice, please sign and return your card *at once.* We have to guarantee our reservations. The reunion will be as usual, STAG and we'll send you a list of Boston hotels for your famliies or for Sunday night. See you there! It may be our last reunion!

Our first Christmas card came from the **Ken Boynton**s, an excellent picture of them to announce their 50th wedding anniversary. They had just returned from a 3,000 mile drive thru Canada and New England to see the fall foliage. Our second card came from Pearl and **Lou Zepfler** in Tucson. Louie says: "You deserve the best for your able stewardship of the Class Supreme." Thank you, Louie, I like that "stewardship" bit!

We received an encouraging line from **Charlie Gardner** in Cleveland: "You're quite a guy and performing miracles with the Class Notes is easily within your capabilities." Now, that will keep me floating on high for some time—Thank you, Charlie.

The 56 cards we received from widely scattered Classmates and their families were a warm reminder that the joy of

Christmas is a good deal in living with the memory of fine, old friendships. Helen and **Bert Adams**'s was a wood cut of a 1513 Medieval Theatre. Serious and dignified **Phil Alger** is pictured with his 2-year-old grandson, Grant, working on a jig-saw puzzle. Evelyn and **Sam Berke**'s a white central space surrounded by a frame of pretty hand painted holiday ornaments. Beulah and **Earle Brown** wrote "You should be real busy the next few months arranging for our 55th. We're in good health. We enjoy reading your wonderful column in the *Review*. We expect to see you in June. (Yes, the old Pirate and I are busily planning our 55th). Marjorie and **Whit Brown** from "Way down yonder": "Well, we made it again to Florida, although each year it takes a little longer to get unwound. But everything is OK and I've had my annual physical by the Doctor down here that I like so much; and he says the old ticker is better than ever, but he is a little more fussy about diet, which rather burns up Marj—nothing serious. Have you made your cruise reservations yet? My best to all the gang, and will try to make my Marlboro meetings so they'll not interfere. The April meeting is the 25th, so don't have the dinner on the 24th! Will be at the 55th no matter what."

John Dalton in a touching note says: "The 'Merry' part of Christmas has left us, but it does not exclude the happy memories of the past and the religious significance of the day." From Lydia and **Jack Dalton** a bright, shiny red and gold card. Fran and **Henry Daley**: "Hope this finds you both well and happy. Nothing startling has happened since we saw you in June at the 1915 Cocktail Party and Dinner. Our best to you both and remember me to any of our classmates when you see them." **Ray Delano,** Duxbury, Mass.: "I saw **Larry Bailey** this a.m., called at **Bill Brackett**'s but he wasn't home—as usual. I send this with kindest regards to you and Frances." From that awful snow belt in Corning, N.Y. Helen and **Otto Hilbert:** "We are both well and hope you are, too. We have had a lot of snow since December 1. It looks nice but I also like swaying palms and warm breezes like we had on our South Pacific trip." (So do we, Otto).

Ester and **Ken Johnson** had been in Barrington, R.I., just long enough to spend a little time in the hospital. Too bad, but they are better, now. **Ben Lapp**'s son, Marshall, is back with G.E. in Schenectady, after a year at the University of Newcastle. Helen and **Boots Malone** invited us to their winter place at Sarasota, ah me! On an original card, dated 1930, an old fashioned tree and verse carried this message from Bee and **Charlie Norton:** "Fifty years ago we began designing our Christmas cards. We thought it would be fun this year to repeat the one we liked best." Marion and **Vince Maconi** think it's almost time for another reunion in the spring. (Yes, it is.) Lucy and **Harry Murphy**'s son Peter with his wife Regina sent an unusual and original card—a picture of each of their six children outlined in a five pointed star, neatly arranged on the front of a folded card.

Ben Neal's "a toast to old friendships" was on another of his cute, original cards, a colored print of his daughter Barbara, Fran and me sunning ourselves last August on the porch of his Cushing's Island, Maine, summer place. It's a good shot of the two ladies—but of me—awful! **Mary Plummer Rice:** "A blessed holiday season to you both. I'm looking forward to seeing you all in Cambridge in June. Then I'll be off to the Paris U.S.O. and to Frankfurt, where, at last, a U.S.O. Club will be opened. Then, on to Vienna and Dubrovnik with my daughter, who will be with me for the month of September. My granddaughter, Wendy, is getting a Ph.D. at the University of Minnesota. She's a brilliant girl. I'm hoping I can get her into M.I.T. so she can see 'how the other half of the world lives.' " We all simply must admire Mary's interests, energy and determination. She's wonderful!

Again, **Al Sampson** sent an unusual and attractive silk print of a Chinese holiday scene, made in Milan, Italy. **Bill Smith**—a reproduction of a Currier and Ives winter scene. A nice message from Margaret and **Ray Stringfield:** "Only 13 more days to Christmas, and we're just starting to get our cards off, altho we have received a basketful already. People send them earlier than they used to. We went to the annual Christmas party of the Los Angeles Rubber Group (TLARGI) at the Century Plaza Hotel last night, and I got introduced again as the guy who organized the group back in 1928, 41 years ago. It has about 750 members now, and supports the TLARGI Foundation at U.S.C. with a full time Professor and several fellowships, and a lot of courses in rubber technology. I don't know enough to retire yet. Have to fly to Oakland Monday to inspect two tires involved in accidents. Be sure and see us if you get out this way, and a very Merry Christmas to both of you."

Another friendly note from Joanna and **Bur Swain.** "I do hope you and Fran are enjoying very good health. We here are; and everything is OK except weather. It is cold, and sometimes raw, as well. Where does the boat go this year? Be sure to stop here when you go south, at anytime." They refer to the sailing parties they used to attend when we were taking off on winter cruises. And, they were fine company. With snow and ice piled up all around us here, Lena and **Jim Tobey**'s note surely is aggravating: "We are back in Florida for 17th season. It has been in high 70's, so we suffer! Son Bill drove us down this year, but I get around OK. Better come down and toast your dermis." Charlotte and **Carl Wood** sent a "handsome" colored print of the M.I.T. delegation, including **Jack Dalton, Archie Morrison** and me, who attended their 50th wedding celebration at their lovely Peterboro, N.H. place last September. A touching message from Polly and **Louie Young**: "Fond remembrance to you both with best wishes for good health and every happiness—always." Long distance cards came from Margaret and Gilbert Mar, '52, Tapei, Taiwan and Carmela and Gus Gross, '50, Guayaquil, Ecuador. We also heard from families of deceased classmates; an impressive list.

Long may the flames of these fine, old friendships brilliantly burn to light our lives in the future—many thanks, many blessings to you all.

Before leaving for the winter in Florida, **Larry Landers** set up our annual New York dinner at the Chemists' Club there for April 24, 1970. So plan to be there and hear the final arrangements for our 55th reunion June 12-15, 1970 at Coonamessett Inn, Falmouth, Mass. Detailed notices will be sent in the spring.

Typical of his usual interest and generosity, **Sam Berke** was one of the Sponsoring Committee for the Underwood-Prescott Professorship in the Department of Food Science at M.I.T. This will be the first endowed chair in the field of food science in the United States.

In the August 1969 *Spectrum,* **Phil Alger** had a very learned paper, "The New Responsibility of the Engineer." His theme was: "Engineers and scientists are responsible for the technical progress that has been made and they have expert knowledge of what can be done next. For this reason alone, they must take part in deciding public policy. However, the modern technical man has a further contribution to offer—the ability to understand the views of others, and to incorporate these views into the best possible group decisions."

With a generous check for the Alumni Fund, **Dick Bailey** from Philadelphia wrote: "I lead quite a sedentary life and rarely leave the house. My health is good, my stories are not so good. But why should I bring that up? I have some short puns based on the use and meaning of the English language. I look forward to the pleasure of seeing The Pirate and the others at our next New York class dinner." That check gives Dick the privilege of keeping us up late at our next New York dinner and telling his awful, corny stories. But, he's the life of the party and we're always glad to see him.

Like a lot of us **Joe Livermore** has been upset over the recent student unrest at M.I.T. and writes: "I enclose a copy of a letter I recently sent to President Johnson of M.I.T. expressing my concern over the phasing out of the I lab and the threat to Lincoln Lab. I'd like to know who runs the Institute 'the small but very vocal group of students and faculty' or the Corporation and Administration. It has certainly come full cycle since our time! The current *Technology Review* under 'Defense Research and the Public Interest' throws more light on the matter and I earnestly hope the defense of this country will still look to this great national asset for help in the future. As for me, I'm still putting together large

plants for Lockwood-Greene. Just now an expansion for Geigy Chemical Corp. of Taffron, N.J. Our grandson, Tom Reid graduated from Yale and was married in June. He is now enrolled at Leland Stanford with a 3-year grant for his doctorate in ecology and biology with its bearing on pollution problems. Hope to make it to our 55th next June, the Lord willing." We hope **Louis Zepfler** will have recovered from his unfortunate troubles so that he can be with us for our 55th. It was good to see him at our 50th. He always adds a lot to our party. "Yes—I want very much to come to the Reunion IF I AM ABLE. I am suffering from a disintegrated right hip, I can get around with some pain. This can be corrected with surgery but I hesitate to submit on account of my bronchial and emphysema condition."—**Azel W. Mack,** Secretary, 100 Memorial Drive, Cambridge, Mass. 02142

16

Only three more months to our 54th reunion on June 12 to 14 at that favorite of favorite spots with its Cottage G headquarters—Chatham Bars Inn, Chatham, Mass., way out at the southeast end of Cape Cod. Can you almost see the azure blue ocean expanse, sense the light salt air and pine-needle aromas and hear the jingle of tales that are all the merrier because—well, just because? In mid-December we had a cheery call all the way from Bogalusa, La., from Sylvia and **Vertrees Young** and also from their house-guests, Mildred and **Art Shuey** of Shreveport, La.—all of whom will be with us at the 54th reunion in June. So, as our ever-going president **Ralph Fletcher** says, "If you live either closer or farther away than Bogalusa, plan now, mark your desk calendar or the one in the kitchen, so you'll be sure to be there on the Cape come June 12, 13 and 14."

Guaranteed Weight Reduction

First let us present something quite timely, useful and even important—something offered in all seriousness early in December by our Colonel **L. O. F. Hastie.** In response to our request for "something" or even "anything," he writes that our note reached him just at a time when his new weight reducing program was really just proving itself. His weight reducing diet scheme which he says he thought of all by himself and which has no connection whatever with his temporary abstinence is so simple and direct, he finds it hard to understand why it took him almost 75 years to fetch it out from his subconscious, which, he is convinced, knew about it all the time. He says, "I have no patent on the idea and I am glad to share it with my comrades. Reducing is, in itself, simple enough as we all know—the real difficulty is to hold the loss. But I will guarantee that my system is infallible so long as it is followed. One starts with a calendar, a red pencil and bathroom scales. After finding one's present weight on the scales, one enters this on the present day of the calendar with the red pencil. One then marks on the calendar, with one's red pencil, for alternate third and fourth days, a figure progressively one pound lower. Starting the following morning, one weighs in an hour before breakfast time, lunch time and dinner time—every day. If at any time the scale weight fails to fall within the appropriate figure on the calendar, one simply holds one's caloric intake at the next meal within 100 calories. For this I recommend either Campbell's consomme or chicken or turkey soup with noodles. A whole can will not exceed this allowance. To stem any hunger pangs between scale readings I suggest a stout beaker of either tea or decaf, flavored with either tomato or fruit juice and topped off with a shot of barbeque sauce which gives a tangy flavor to the drink.

"I have so far reduced only 15 pounds but I will continue marking my calendar off one pound alternately every third and fourth day until I get down at least 12 more. To hold this loss I will simply carry my desired weight forward on the calendar and continue with the system. Voila! I will guarantee this system, which for euphony I like to think of as LLOF WRDS, if conscientiously followed. I will admit that I toughened my moral fibre before starting this LLOF WRDS, by staying reluctantly on the wagon for a month first. I don't know whether I could have done it in cold blood or not. Anyway, one and all are invited to adopt this, the only infallible weight reducing scheme I know of (and, weight holding scheme, which is the toughest part). Well, warm regards and Vaya con Dios." And then a postscript: "P.S. One must have enough moral fibre to be impervious to the little woman's Ugh! when she sees one adding the barbeque sauce." This is all signed: "L.O.F. (Lovable Old Frank) Hastie," which helps one to understand and figure out the meaning of alphabetical designation used by Frank for his sure-fire system.

Our Travelers

Hovey Freeman tells of a colorful 10,000-mile airplane trip he and his wife took last spring in 10 days "to visit our widely scattered family—a daughter and her husband in Minneapolis, my oldest son and his wife in California, my brother-in-law and his wife in Nassau and then to Puerto Rico to visit my youngest son and his wife and family." Hovey adds: "Since then I have been pretty much here at home where I can work in my shop when I feel like it or sit back and read and watch television when the old feet give out. I still find my three directorships very interesting although I must admit that otherwise I am pretty much of a loafer. Sorry I couldn't get to the reunion but I am hoping to next June. Two new great-grandchildren arrived a couple of months ago so we now have quite a gang—six married children and their spouses, 21 grandchildren and five great-grandchildren."

In the fall, the **Merrick Monroe**s took a two-month cruise to the Mediterranean on a Norwegian freighter in which they touched at the Conway Islands, Genoa twice (once east- and once west-bound), Naples, Beirut and Latakia, Alexandria, Leghorn, Athens, Palermo and Seville. Says Merrick: "We were impressed with the enormous transoceanic trade. We went up Vesuvius, right to the ever-smoking crater, explored Pompeii, saw the temple ruins of Baalbek (Lebanon) and the Acropolis, Athens. An excellent cruise, food, accommodations, etc., but the Atlantic roughed us up a bit."

In late fall, we heard from the **George Mavericks** of Charlottesville, Va., who were soon to drive down to San Antonio to attend his brother's Golden Wedding anniversary on December 27. Says George: "Along with ours, and the anniversaries of two brothers and two sisters, that'll be the sixth and last of my father's kids. None of us has reached the seventieth wedding anniversary as he did. We'll probably drive to Mexico for a month and stay mostly in San Miguel D'Allende. Getting to hate the snow in our long driveway and we must face the horrible idea of changing the farm for an apartment soon."

More from Down South

In mid-December Gyps and **Cy Guething** took off for their winter stay at the Seagate in Delray Beach, Fla., where, as Cy says, they will be among friends but not their own family. The latter "will all be skiing out west and we are too old to even watch it. Takes kids like Ralph Fletcher to both do and watch it!" . . . **Dick Knowland** in Largo, Fla., says he has little of general interest to report "having been rather closely 'confined' to Florida except for the usual late-summer trip to the North. The gardens here give a real lift to the spirit and I send holiday greeting to my classmates." . . . **Howard Hands** in Clearwater, Fla., says we ought to try Florida and get away from this snow-shoveling. His advice was well-timed at Christmas with our 10 inches of snow, Albany's 34 inches, and somewhere-in-Vermont's 50 inches. Howard notes he has resurrected his stamp album, Alice does a bit of painting and they have their bridge. His contribution to the latter is undoubtedly an extension of the games he was always playing in the smoke-filled room in was-it-Engineering-C building, as he hand-rolled cigarette after cigarette with wheat-straw papers.

Andy Witherspoon sends a bit of history from Sarasota: "As you possibly know, I started in Course I with the Class of 1915, But after three years I 'ran out of funds' and took the exam for the U.S. Coast and Geodetic Survey. I got leave from them to finish with the Class of 1916. After graduation I went back to the Survey. When the war started we were all transferred to the Coast Artillery and sent to France as officers in the Railroad Artillery. Then after the war I was sent down to the newly acquired Virgin Islands with a mapping party. I spent about a year there and then went to Baltimore with my war bride and went

into the contracting business. Last year my present wife and I made a trip to the Virgin Islands—fifty years has made quite a change." . . . From Winston-Salem, **Arvin Page,** writes that time goes so fast nowadays that he can't begin to keep track of it. Says: "The hours, days, weeks, months and years come and go much more rapidly than they did half a century ago or even 10 or 15 years ago. This is direct contradiction to all I read before I retired. All of this material stressed the frustration of retired men when they found themselves relieved of the pressures of business. I have not found anything but sublime relief at the absence of deadlines and now you come along and endeavor to saddle me with one but I refuse to be intimidated."

Helen and **Allen Pettee**'s Christmas card showed them both well groomed in matching red outfits, Allen in the familiar natty red sport jacket of our own 50th reunion. Allen notes that they like very much better their new location in town (Tryon, N.C.) and are gradually bringing the old house up to modern standards of comfort.

Out West

Ken Sully of Laguna Hills, Calif., tells of a motor trip that he and Emerald took to Arizona and New Mexico where he mined for 10 years. In Tucson they had a most pleasant visit with Virginia and Joel Connolly; further: "Later we drove to British Columbia, returning by way of the Olympia Peninsula and the coasts of Washington, Oregon and California. Recently we had the pleasure of meeting the 1970 Rose Queen at the Tournament House in Pasadena. We have been in touch with Kay and Irv McDaniel and are looking forward to having them as our neighbors here in Laguna Hills Leisure World." . . . **Willard Brown** of Santa Barbara gives us an interesting item, something that came up at his home in November as Dorothy, who was chairman of the Tea Committee for their 1,500 member Women's Club for December, entertained some ten lady sub-chairmen for coffee and cakes. One of the ten was discovered to be our own Mrs. **Maynard Cameron Guss,** with whom we last had word at the time of Maynard's death in Santa Barbara in 1965. She mentioned a life-long friend of theirs, Harvey W. Daniels, whose picture appears with ours in the 1917 *Technique* but who is registered as of the class of 1915.

From Elsewhere

Ed Hall of Baltimore spent November in Marathon, Fla., arranging for "maintenance work on my small house there," returned to Baltimore for Christmas and New Year's to be with the children and grandchildren, and then went back to Marathon to stay until May. . . . **Earl Mellen** continues more than active as Chairman of the Board of the Hospital Service Plan of New Jersey (Blue Cross) and gets entangled in hearings that get entangled with increasing hospital costs. He notes that his greatest recent pleasure was in November when, as a holder of the Silver Beaver Award, he presented the Eagle Scout Award to one of his own grandsons, Howard Mellen.

John Gore writes from Canajoharie, N.Y., that all goes well—he and Gretchen look forward to the 54th reunion in June. . . . Martha and **Nat Warshaw** have moved from their beloved Hull, Mass., home to an apartment in Randolph. Says Nat: "We like this place very much. It really is in a glen but the glen is as high as the Blue Hills which are between us and Boston. On the expressway I can get to the office in 20 minutes if it is not the rush period. I spend only the morning there and never have difficulty returning at noon." Worrying a bit about things in general, Nat observes: "What we all wouldn't give to be able to turn the clock back to our pre-'16 days. Those were the happy days without a doubt!"

Duncan Owler of Fall River enjoys good health—plenty of outdoor exercise playing golf three or four times a week the year around, weather permitting, plus swimming in the summer. Says he keeps active in financial matters, computer technology, business, music and sociology "if you can call it that in these unusual times. Never a dull moment!"

In conclusion, your secretaries wish to express their appreciation for the many beautiful cards received at Christmas time, and also for the generous response to our little requests for news and bits of philosophy. From now on, at our joint monthly '16-'17 luncheons at the Chemists' Club in New York, we will greatly miss Dix Proctor, 1917's class secretary, who has been so regularly active in helping to keep these enjoyable meetings going, but who in mid-December passed on. And looking ahead, keep the 54th reunion dates in mind, June 12, 13, 14, and continue to write a little but write often to your still willing-to-work secretaries.—**Harold F. Dodge,** Secretary, 96 Briarcliff Rd., Mountain Lakes, N.J. 07046 **Leonard Stone,** Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

17

We have had our 50th reunion and now it is the 50th wedding anniversaries that get attention. The **Cy Meddings** had theirs in July when most of their two sons, two daughters and fifteen grandchildren got together at Springfield, Va. Cy had 36 years in the Army and among his awards are the Legion of Merit, the Order of British Empire and the Order of Crown of Italy.

As the Bridgeport (Conn.) Engineering Institute observed the 45th anniversary of its founding, tribute was paid to **Arthur E. Keating,** the Institute's founder and its first and only President. In June, Arthur's role as founder was recognized by the University of Bridgeport, which awarded him the honorary degree of Doctor of Laws, and the Florida Institute of Engineering, which awarded him the honorary degree of Doctor of Science.

The B.E.I. was founded in 1924 to provide persons employed in Fairfield County area industry with an opportunity to obtain night schooling in fundamentals of engineering. In 1943 a Stamford division was opened, which today also offers a full baccalaureate program. Arthur was recognized by the Florida Institute of Engineering for his help and encouragement in its founding. At one time he was chairman of the Industrial Engineering Department at Northeastern University. He is a member of numerous professional societies and continues in consulting capacities.

When the notice for the 52nd reunion was sent a return postcard was enclosed. Its purpose was two-fold. We wanted to know who would be coming and also we wanted to hear from those who could not come. We got 116 replies out of 318 notices. On these cards 46 of you made some comment and 45 did not. The comments are appreciated for they help with these class notes and it is expected that excerpts will appear from time to time. We were pleased too, to have 17 widows respond and show their interest even if none could attend. Better luck next time, we hope.

Newburyport, Mass., welcomed a hometown boy who made good when it greeted **Robert S. Mulliken** at its annual Yankee Homecoming in August. A new street in the Lord Dexter Industrial Green was dedicated as Mulliken Way.

During this past year **Dix Proctor** asked several members of the Class to try to get notes from men in their areas. Notable efforts were made by **Bill Dennen, Brick Dunham, Howard Melvin** and **John Holton** and some of their results appear.

Walter Pond puts in his time between Malvern, Ark. and Greybull, Wyo. His letterhead indicates that he is a "Consulting Geologist" but his note, expressing regret at not attending the 52nd to the effect that if you want to stay well don't grow old, would indicate that his consulting may not all be in geology.

An interesting letter from **Harold Perry** from Trenton, N.J., refers to the fact that he was at the Institute only one year on graduate work but he recalls **Phil Cristal, Dud Bell** and **Dick Loengard.** Harold's comment on retirement reflects a finding of many of us for he states: "Since retirement I do a number of things that make me wonder how I ever found time to work for pay: Chairman of a settlement house in Trenton; member of George School Committee and a number of sub-committees; I record for the blind in Princeton two mornings a week (and am secretary of the Board of the Princeton Unit); activities with the Human Relations Council in Trenton and various engrossing jobs connected with the Society of Friends."

Jim Flaherty is back from Ireland which he says is good sketching country. He made four watercolor sketches on the

spot in Glenbeigh which now hang in Kenny's Galory in Galway. Since neither Jim nor **Enos Curtin** comments, it appears evident that the fox that Enos was chasing with the Galway Blazers, County Waterford, County Clare, did not run onto Jim as he painted. Enos also rode with the Scarteen which is the famous Black and Tan pack that have had a Thadeus Ryan as Master for about 120 years.

After some consulting work in Santa Domingo **Ken Bell** got back in time to see the **Ray Blanchard**s and deliver the 50th wedding anniversary scroll which many of us signed at Northfield. He found them well and appreciative of the remembrance. Next it was the **John Holton**s' 50th where Ken emceed the celebrating dinner with 79 guests present including the **Stan Lane**s. Maybe the Ken Bells and the Dennens will run into each other "down under" for on last word both were getting away early in January for Australia and New Zealand to return via Hong Kong, Japan etcetera. The Loengards and the Erbs are just back from those parts having joined up in Japan for covering Tokyo, Nikko Hakone, Kyoto, the inland sea and Osaka. The Erbs then went on to Singapore while the Loengards stopped off in Hawaii returning.

Tom Searles certainly has had an interesting and active career. Coming to M.I.T. from Mississippi and a Naval Academy diploma he had war work for several years then got into business by way of manufacturing, starting a finance company, doing a study of the Veterans Administration for the Hoover Commission, and organizing a company to print on plastics. He lives in Philadelphia and is president of Federal Yeast Corp., the Gold Star Foods Company which distributes frozen pie fillings and other baker's needs to large bakers. He also has Bakery Products, which manufactures mixes and concentrates for bakers. This all sounds as though he keeps really busy.

When in Chicago recently **Al Lunn** phoned **Rad Stevens** and learned that Rad keeps active business-wise but not so much as to interfere with his golf for he got in 85 games last year.

Walt Whitman was recently recognized for being a 50-year member of the American Chemical Society. From 1960 to 1962 he was science adviser to the Secretary of State. In 1951 he was chairman of the Research and Development Board, Department of Defence and in 1955 became Secretary-General of the U.N. Conference on Peaceful Uses of Atomic Energy.

The deaths of three of our classmates are regretted. **Francisco Sada** died at Monterrey, Mexico, this past summer.

Joe Gargan died on New Year's day. He had stopped his car and collapsed over the steering wheel. He was with the Veterans Bureau for years and had been teaching at the Franklin Institute in Boston for the past 12 years. It will be recalled that Joe, Bob Erb and Jimmy Doon were track men.

J. Henry Staggs, Jr., died on November 18th. He had gone to his office as usual but suffered a massive stroke soon after arrival and passed on. He was President and Treasurer of The Hawley Hardware Co. (mill supplies) Bridgeport, Conn. He is survived by his wife Elinor, a son Joseph Henry III, a daughter and his brother Dwight.

During the past year several letters and Christmas cards for your now acting secretary were sent to his old Cambridge address. Please note that his correct address is—**Stanley C. Dunning,** 6 Jason St., Arlington, Mass., 02174

18

Remember, back in 1914 and 1915, Engineering A, B, and C buildings on Trinity Place where our quite modest commons dining room was housed. Then in 1916, we moved across the river to the magnificent Walker Memorial with all its facilities for student activities.

Now there are three buildings serving these purposes for the M.I.T. faculty. Walker, Kresge Auditorium, and the new splendid Stratton Center—and still more space is required. I should mention also the M.I.T. Faculty Club with its excellent meeting and dinning room services, which occupies the entire sixth floor of the Alfred Sloan Building.

Recently, I wandered through the upper floors of Stratton and inspected some of the quarters for Technology Christian Association, The Tech, Technique, music practise rooms, and many others—all very impressive and full of activity. In particular, I liked the M.I.T. Student Art Association which sponsors evening programs for beginners. The workshops include silk screen, jewelry making, sculpture, painting, life drawing, photography, design, pottery, and so on. There are two professional instructors in charge of these classes—augmented by advanced students who offer their skills. About two hundred of the M.I.T. family are taking advantage of these courses. I believe many of us would have enrolled in this cultural activity in our day, had it been available. Tech marches on!

I am happy to pass on to you greetings and news received from classmates during the Christmas season, even though you may not be reading them until the next holiday, Easter. **Sumner Wiley** reports no new scientific break-throughs or professional distinctions, but he promises items of interest about New England ancestors—later. . . . **Sax Fletcher**'s season's greetings from Cloverly Farm includes many pictures of various buildings on his place. . . . **Marguerite Wills** sent her card with a photograph of the house she and Bill built at Great East Lake and where they were able to enjoy so many happy times together in years gone past.

John Clark's greetings from Clarksdale, Miss., included the following message. (By the way, John, are you responsible for the town being named Clarksdale?) "I'm a little ashamed of the Institute for letting students bluff them out of their military research. God knows I agree with the young folks that war is a primitive and savage business, but if they think they can eliminate it in one generation, they are gravely deficient in a sense of realism. Growing up is tough!

"It seems to me that Mr. Nixon and Mr. Agnew are doing about as good a job as anybody would. . . . Unless I am mistaken, Allston is named for a relative of mine who got run out of the Carolinas because his kinfolks didn't approve of him. I think he was an artist."

We are particularly happy to receive news from the **Ed Rossman**s from Tucson, Ariz. You will recall that Ed has had a pretty rough time health-wise during the past year. Dorothy reports Ed has regained strength and coordination and best of all, he takes a real interest in doing things again and enjoys life. In the meantime, Dorothy has put back some of the 18 pounds she lost and I am sure she will be a welcome sight for sore eyes when they return to New England, hopefully this summer. Keep up the good work, you two, and more power to you.

I was happy to receive a season greetings card from Anna and **Jorge Pena Polo.** They are still in New York City. . . . There were also greetings from Eleanor and **John Kilduff, Pete Strang,** Frances and **Pete Harrall,** Elizabeth and **Julie Howe,** and Dot and **Clarence Fuller.**

Greetings from Biscuit and **Sam Chamberlain** came in the form of The New Calendar for Engagements liberally sprinkled with many photographs as only Sam can take them of authentic early New England scenes.

Through the grapevine we have news of **Mike Flett,** now residing in New London, N.H., home of Colby Junior College. He and Dot like the rugged winters so much they stay there to snow shoe in the woods of that Fairy Land. A daughter married an M.I.T. graduate from Sweden where they are presently located with their three small girls. The husband is president of a small steel company. . . . Finally, Dorothy and **Granny Smith** include in their card a most interesting description of their visit to Europe last summer.

As some of you know, we have sold our house which we occupied for 30 years and are now cliff dwellers in a new apartment house in Brookline: 60 Longwood Ave., Apt. 808, Brookline, Mass. 02146; same telephone, AS 7-7750. Please call us when you come to Boston, and let us have a chat in a living room that offers a splendid view of Boston's burgeoning sky line.—**Max Seltzer,** Secretary, 60 Longwood Ave., Apt. 808, Brookline, Mass. 02146

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Paul Blye wrote in sending a clipping on the death of **Al B. Reynolds.** Al was a retired Bell Telephone Labs supervisor and passed away at Morristown on January 24, 1970. Paul plans on spending March on Sanibel Island off the west coast of Florida.

Louise and **Leo Kelley** sent a beautiful Leonardo de Vinci Xmas card with all the holiday wishes. . . . Captain **E. E. Saunders** has sold his home at Asheville, N.C. and moved into "Vinson Hall' in McLean, Va., an apartment structure built by the Navy, Marine Corps and Coast Guard Foundation where retired couples, widows, and mothers of N-Mc-C or officers may buy lifetime occupancy. . . . **Francis Weiskittel** writes his approval of the 50th reunion and compliments the Institute's alumni staff. He has some snapshots which we hope to see then.

Louis Grayson also expressed his pleasure at the reunion. He spent July in Hawaii, October in New England. . . . **George Bond, Jr.,** writes of his busy activities—scouts, Y.M.C.A., Kiwanis, Church Building Loan, United Fund, etc., and travel to his family near Boston, Chicago and Florida. In August he drove 7,400 miles to Colorado and Utah with his sister.

Erwin M. Kenison likes retirement in Florida. He plays a lot of bridge and shuffleboard and takes short trips around the state.

Dean Webster, Jr., president of the Lawrence General Hospital Board of Trustees, has accepted chairmanship of the Trustee Division for the joint Bon Secours—Lawrence General Hospital's fund raising campaign.

Marshall Balfour wrote all about their year. They are selling their home in South Kent, Conn., in 1970 and moving into a smaller warmer place in Princeton, N.J. Columbia, Md. or Chapel Hill, N.C.—the basic requirement being a university setting. Bal spent Xmas in Cincinnati and after New Years was in Bethesda, Md.

Your secretary sold his home at Scarsdale, N.Y. and will be permanently in Barr Terrace Apts. Delray Beach, Fla. after March 1, 1970.—**Eugene Smoley,** Secretary, 111 Casuarina Rd., Delray Beach, Fla. 33444

20

That this is an auspicious year for the Class of 1920 has been evidenced by the extra large number of year's end greetings to your plodding but faithful secretary. Among those heard from, thus gladdening the heart of the old codger, were Betty and **Norrie Abbott,** Esther and **Frank Bradley,** Winnie and **Frank Badger,** Betty and **Al Burke,** Pat and **Buzz Burroughs,** Mary and Buch Clark, Barbara and **Bill Dewey,** Billie and **Dick Gee,** Luey and **Jim Gibson,** Vera and **Homer Howes,** Polly and **Ned Murdough,** Laura and **Bob Patterson,** Beth and **Ed Ryer,** Denise and **K. B. White** and **Stan Reynolds.** Bless them all, and grant me the privilege of thanking them in person at the grand and glorious 50th.

Our distinguished class president has a new address. Norrie and Betty have moved to a delightful, modern apartment, top floor, which overlooks Narragansett Bay—address, Apt. G-3, 1180 Narragansett Blvd., Cranston, R.I.

An enormously welcome letter from **Johnny Barker** of 33 Runnells St., Portland, Maine deserves to be quoted in full. "After these many years of silence I think I should like to report to such of those classmates as may remember me that I am alive, well, happy and growing old like everyone else.

"Although I actually graduated in 1921, I spent only my last two years at Tech with that class having entered with and spent the first two years with 1920. The interim year was accounted for by service with what was then the U.S. Marine Corps Reserve Flying Corps. At any rate my diploma reads '1921 as of 1920' and my memories go back to the names I see in your alumni notes with whom I shared many good times in class athletics working on Tech Show, *Technique,* Beaver, and in the classrooms of Professor Schell in XV_2.

"I am now retired from a career in, of all things, hospital administration as Executive Director of the Marine Medical Center in Portland. The past six years of retirement have been happy ones. Just enough work as Consultant in Hospital Administration to the state of Maine Department of Health and Welfare and as director in various voluntary health agencies has left me free to enjoy Siesta Key in Florida for a month each winter and my cottage at Sebago Lake, Maine, in the summer. The only classmates with whom I have corresponded over the years are Dozie Brown and June Bartlett. My very best regards to any of those classmates who may remember me." Let us hope that Johnny makes a special effort to attend the reunion, for he is certain to find many friends and classmates who remember him well and will be more than happy to see him again.

Phil Young writes that he and his wife are living in Westfield, N.J., as they have for many years. He has two daughters and two sons, all married, and no less than eight grandchildren. He spends summers in Vermont in the village of Landgrove which is in the vicinity of Londonderry and Peru, and would welcome any of the Class if they are in that area. Says Phil, "Westfield is a center for M.I.T. graduates and I run into many of them. I hope to be able to come to the 50th next spring, my wife driving." Be sure you will get a warm welcome, Phil.

Freeman Dyke of 192 Golfview Drive, Jupiter, Fla., writes that he and Alma have just returned from a five month's trip around the world, most of it south of the equator so that they escaped the summer heat of Florida. A veteran retiree, Free keeps busy golfing, fishing, traveling and, for another hobby, is a noted cook. His sons, Freeman, Jr., and Peter both graduated from M.I.T., Course X. "We have three grandchildren and I hope one of them makes it there." Free says that he has seen **John Crowley** and that John promised to make the reunion.

Bob Bradley writes that he and Ruth have been busy getting settled in their new apartment at the Somerset in Gulf Stream, Fla. He says he was sad at leaving so many M.I.T. friends at Naples but anticipates chopping away at the new Dunes Country Club. Bob says that as usual they are smack on the ocean. Their summer home is in South Dartmouth, Mass. The Bradleys are counting on being present at the reunion.

Gertrude and **Jim Wolfson** are also planning to attend. Jim retired as Vice President of Tishman Realty and Construction Co., New York City, and since then has been acting as a construction consultant on a couple of large building projects. He has been looking forward to his annual winter vacation down South. Jim's home base is 342 Beach 142nd St., Neponsit, Long Island.

Art Radasch of 14 Captain Small Rd., South Yarmouth, Mass., writes that he and his wife keep busy with their favorite occupation, geneological research. They have had two articles accepted for publication in the N.E. Historical and Geneological Register and have been appointed by the Society of Mayflower Descendants to couple an account of all descendants to the fifth generation in the family of Samuel Fuller of the Mayflower. This project has taken a good portion of their spare time for the past two years and it will be a part of similar accounts of all 23 mayflower families.

In September, Art and Mrs. Radasch drove to California via the Trans-Canada Highway and the Canadian Rockies to celebrate their 50th wedding anniversary with their daughter and family in Walnut Creek, Calif. The Class extends belated but none the less hearty congratulations, Art. We wonder how many, if any, classmates have achieved that distinction.

Skeetz Brown writes to advise us that he is now enjoying his "little Brown home in the West" at Colonia Miramonte 68, Scottsdale, Ariz. Skeetz and Margaret planned and built their new home at long distance from their summer home on Shore Road, West Harwich on Cape Cod, and, judging from the sketch Skeetz was thoughtful enough to send me, it is a charming and beautiful ranch type "Casita." They expect a visit from their son and his wife and four children whose home is in New Orleans. They have five additional grandchildren in Salt Lake City and six in El Paso in-

cluding two sets of identical twins, one set girls, one set boys. What a wonderful family! Skeetz says that Pete Lavedan who is a summer neighbor on the Cape, can testify that they converge on the Cape from the far west—not all 15 but as many as 11 at one time. Can any classmate come close to this record?

Jack Logan reports that he and his wife are "in as good health as one can expect at our age." They are living in a restored 1848 stone house in a small village 12 miles southeast of Bedford, Pa., the Borough of Rainsburg on route 326. Mrs. Logan has a green thumb with flowers, shrubbery and vegetables and Jack covers their acre or so with a self-propelled mower. They have a married daughter in Scarsdale, N.Y. and a bachelor son in California. Jack says, "old friends and classmates traveling on the Pennsylvania Turnpike sometimes delight us by stopping off for a visit. The phone number is listed under 'Bedford,' easy to reach from Midway service area."

Don Kimball of 76 N. Country Club Drive in Rochester, N.Y., writes that a serious operation last August has delayed his promise to attend the reunion but he is keeping open minded on the subject. Don plans to spend three months at the Seagate Hotel and Beach Club, Delray Beach, Fla. We sincerely hope that this will prove so beneficial to his health that he will not fail to show up hale and hearty next June.

Harold Hedberg of 3333 N.E. 34th St., Fort Lauderdale, Fla., sends a most interesting account of his activities since graduation. He and Ed Brickett, whose death was reported in these columns some five years ago, joined the engineering department of a paper mill in Maine. Ed returned to Minneapolis and Harold returned to M.I.T. where he served as assistant to Professor Haven, Machine Design, for several years. Harold then became associated with Albany Felt Company where he stayed until retirement. He had charge of manufacturing for this renowned producer of paper machine felts and other industrial fabrics. Later he headed their research department and was made a vice president. One of the company's acquisitions was a felt mill in Southern France and Harold went abroad to operate the mill. He married an Albany girl and they have a daughter who lives in Swarthmore, Pa., and is married to an orthopedic surgeon who is executive officer of the Naval Hospital in DaNang, Vietnam. They have three children. Their son, also married, assistant vice president of Pacific Tel. & Tel., is presently on assignment with A.T.&T. in New York and living in Short Hills, N.J. Harold keeps active in Florida and enjoys swimming. He has had visits with Frank Hunt and Frank Badger. He looks forward to the reunion.

Karl Bean now lives at 55 Early Redberry Lane, Yarmouthport, Cape Cod having moved from Goffstown, N.H. Karl visited **Pete Lavedan** in Harwich and found Pete and his wife about to take off for Greece and the Aegean islands, due back in November.

1970 Alumni Fund

as of

January 27, 1970

Class	Donors	Per Cent	Dollars
1911	47	47	$3,945
1912	49	46	3,666
1913	51	39	3,498
1914	48	41	16,165
1915	71	43	11,592
1916	74	37	41,380
1917	89	36	36,017
1918	62	28	4,766
1919	51	24	22,077
1920	117	43	54,167

A welcome note from **Lancy Snow** of 309 Marius Rd., North Port Charlotte, Fla. says that he "attends the Southwest Fla., Alumni Club dinners and picnic, putters around the house, plays bridge and conducts other such harmless pursuits." Lancy continues, "Mrs. Snow and I plan to attend the 50th reunion, God willing, and look forward to a nice gathering."
A letter from **Bill Honiss,** LLAVE DEL ORO, 272 Key Palm Road, Boca Raton, Fla., says that he retired about eight years ago after serving some 42 years with Emhart Corp., Hartford, designing, building and starting up their equipment for automatic production of glass containers. Bill sold their winter home in Pompano Beach and built a new home in the Royal Palm section of Boca Raton. He lived in West Hartford for many years but expects to become one of our many, many classmates now making Florida their headquarters.

Thanks, dear classmates, for keeping in touch and providing this array of news. That time is fast approaching, a time in which we can all take justifiable pride—our 50th! Make your plans and write the good news of your attendance to Ed Ryer or Norrie Abbott or the undersigned.—**Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

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The prospect of the return of spring as you read these words is linked with another important event we anticipate at this time—the annual M.I.T. Homecoming, June 14 and 15. Program details elsewhere in the *Review* may not include the most significant news for the Class of '21 that our annual informal dinner will be held as usual. Following the enjoyable arrangement established some years ago, classmates and wives will gather on Sunday evening, June 14, in the main restaurant of the Charter House on Cambridge Parkway, Cambridge, not far down Memorial Drive from M.I.T. In prior years no time has been set for dinner. However, since M.I.T. is booking Symphony Hall for the Pops concert with Arthur Fiedler on that evening, we will plan to meet between 5:30 and 6 p.m. This will enable those who wish to go to the Pops to have time for both events. It will provide for longer socializing by later arrivals for dinner and those who prefer to spend the entire evening with classmates. We hope to see you and your wife there. And, thinking further to our 50th reunion, both of you should plan now to "Join '21 in 'Seventy-one."

Assists by Mother Bell

A New Year's Day phone call to Helen and Class President **Raymond A. St. Laurent** at their home, 47 Gerard St., Manchester, Conn. 06040, developed that Ray is fast recuperating from what he calls his "nuisance" hernia operation last November and is in excellent spirits. He and Helen are most appreciative of the many phone calls and letters of good wishes from members of our Class and their many other M.I.T. friends. By this time they will probably have visited Boston for a checkup on his previous hip operation. We hope that they will return for Homecoming. . . . Another phone call determined that Graciela and **Antonio H. Rodríguez** are well and happy in their home, Apt. 10C, 4015 Bayshore Blvd., Tampa, Fla. 33611. They sent regards to all in the Class and expressed the hope they would see the group at M.I.T. on Homecoming.

On New Year's Day, we also phoned to congratulate Marge and **Jackson W. Kendall,** 401 Hermosa Pl., South Pasadena, Calif. 91030. The occasion was the first entry of a float in the Pasadena Parade of Roses by his company, Bekins Moving and Storage Co., Los Angeles. It was judged the winner of the Governor's Trophy for the best use of roses in its colorful floral rendering of the Potlatch Indian festival.

Wedding Bells

The welcome announcement reads: "Mrs. Laura E. Franklin and Mr. **Robert W. Haskel** announce their marriage on Saturday, the fifteenth of November, 1969, Greendale People's Church, Worcester, Mass." The Haskels are at home at 8 Grove St., Medfield, Mass. 02052, where we have addressed a special welcome to Laura and good

Laura and Robert W. Haskel, '21

wishes from the Class of '21 for a long and happy married life. Bob answered, in part: "Thanks for your card and letter. Yes, Laura and I will plan to be at the 50th reunion of the Class in 1971 and we also will attend Homecoming '70 next June. We are enjoying our new home in Medfield since we both like the country and open spaces. Laura has three children and 10 grandchildren and I have two children and three grandchildren, all of whom live not too far away, which is rather unusual and very good for us. I met Laura last summer on the Cape where she has a year-round cottage on Old Wharf Road in Dennisport, Mass., and I have a camp nearby at Campers' Haven. Too bad the Cape does not have extensive winter business so that areas like Campers' Haven will not be closed, cold and desolate throughout that season. **George A. Chutter** has a beautiful new retirement home on the other side of the Cape in East Dennis. I see him occasionally during the summer. Of course, you know that the two sides of the Cape are vastly different and those on either one will have no 'truck' with the other! We hope that both of you will have happy holidays and that we'll see you in June."

George Chutter, Chairman of our 50th Reunion Committee, also notified us of Laura and Bob's wedding. He adds: "At the Alumni Advisory Council meeting in Cambridge, I encountered **Mich Bawden, Ed Dubé, Chick Kurth** and **Ace Rood.** Ed told me that Ray St. Laurent had again been hospitalized this time for a hernia operation. I have not heard how things are going but, as he has experienced life in the last year or two, this will probably be a minor event."

Our Appreciation

Each year, Maxine and your Secretary are the grateful recipients of holiday greetings, notes and most welcome annual news letters from our good M.I.T. friends. We deeply appreciate your courtesy and friendship. We enjoy receipt of your news and we and our friends here have the pleasure of seeing your many artistic media light up our Christmas Card Tree. Our heartiest thanks go to Anne and Wally Adams, Olive and Ollie Bardes, Elizabeth and John Barriger, Ednah Blanchard, Ray Brooks, '17, Mary and Buck Buckner, Ethel Burckett, Jack Cannon, '24, Debbie Carciero, Marion and George Chutter, Beverly and Ian Clark, '61, Mary Louise and Rich Clark, Edna and Phil Coffin, Clara and Asher Cohen, Luisa and Nish Cornish, '24, Stephanie Davis, Kay and Ed Delany, Maida and Ed Dubé, Helen and Ed Farrand, Catharine and Harry Field, Alma and Vince Fulmer, '53, Eddie and George Gokey, Jr., Betty and Morrie Goodhart, '35, Margaret Goodhue, Sarah and Harry Goodman, Laura and Bob Haskel, Alex and Munnie Hawes, Betty and Sumner Hayward, Betty and Dug Jackson, Jr., Ruth and Irv Jakobson, Brenda Kelley, Marge and Jack Kendall, Janet Kreiling, Laura and Chick Kurth, Eileen and Moose LeFevre, Betty Ann and Fred Lehmann, '51, Emma and Al Lloyd, Anne McCammon, John Mattill, Elma and John Mattson, Milicent and Joe Maxfield, '10, Helen and Bob Miller, Helen Mosher, Kay and Phil Nelles, Jr., Muriel and George Owens, Conchita Pearson, Marty and Bill Ready, Graciela and Helier Rodriguez, Helen and Ray St. Laurent, Kathy Sayre, Anne and George Schnitzler, Olena and Juan Schwarz, '44, Phyl and Don Severance, '38, Deborah Shapley, Rigi and Saul Silverstein, Madeline and Rufe Shaw, Eric Smith, Edith and Harry Thomas, '25, Helen and Lem Tremaine, '23, Louise Tucker, Maria Helena and Vivi Valdés, Ruth and Ralph Wetsten, Fred Wheeler, India and Dave Woodbury, Dick Wright.

The Postman Rings

A notice from the Alumni Office brings the good tidings that **Robert W. Barker** has returned to the fold and we welcome him back to the Class of '21 most enthusiastically. Somehow, Bob has been officially listed with other class numerals although he spent four years with the Class of '21. We assume the good time he and Charlot had with us at the last couple of '21 interim reunions in Mexico has led him to want a part in our active group.

Moose LeFevre writes that he and Eileen have moved and their mail should now be addressed to Mr. and Mrs. G. Howard LeFevre, The Gloucester, Apt. 15D, 770 Boylston St., Boston, Mass. 02199. . . . **Russell B. Tewksbury** says he has moved his home from Silver Spring, Md., to 52 Stoney Ridge Dr., Hillsdale, N.J. 07642, and we hope we'll see him at future meetings of the M.I.T. Club of Northern New Jersey. We assume the move indicates he has retired as statistician of the Washington central office of the Veterans Administration. Right, Russ? . . . Also reporting a new home address is **Sydney W. Gould,** who can now be reached at 5 Opening Hill Rd., Madison, Conn. 06443. He is director of international plant index, Connecticut Agricultural Experiment Station in New Haven. . . . **H. duPont Baldwin** still lives in Annapolis, Md. 21401, where he has moved to a home at 219 Hanover St.

A. Royal Wood, retired vice president and treasurer of the United Illuminating Co., New Haven, Conn., tells of a new residence at 15 Charlton Hill, Hamden, Conn. 06518. . . . Two of the regular commuter families have reported from the sunny climes of Florida. Anne and **George Schnitzler** have made their seasonal trip from Chestnut Hill, Mass., to 1076 Venetian Way, Miami, Fla. 33139. . . . Kay and **Edward W. Noyes, Sr.,** have closed their summer home in Pennsylvania and will receive mail during the winter via R.D. No. 2, Pelican Dove, Stuart, Fla. 33494. Ed adds: "We like this new location better than the Pompano Beach area where we spent nine winters. We are a block away from the St. Lucie River and have our thirty-foot Chris Craft docked in our front yard, with open access by canal to the river. Kay and I are kept young by our 16 grandchildren." Classmates in the vicinity can reach Kay and Ed by telephoning 305 287-6627.

Yachtsman of the Year

According to the *WindJammer,* published by the Houston (Texas) Yacht Club, the club's Yachtsman of the Year Trophy was presented by Commodore Hobson Carter to **Richmond S. Clark,** who was named the outstanding 1969 power boatman among the club membership. The presentation, made at the formal commodore's ball, gives Rich a year's possession of the large silver cup which bears his name along with those of previous winners. Rich says it took two quarts of champagne to fill, so everyone could have a sip at the ball. He also received permanent possession of a plaque which is now mounted over the fireplace of the new home that Mary Louise and Rich completed last year in LaPorte, Texas 77571, where the mail address is P.O. Box 1400. The honor came as a complete surprise to Rich, who has been a member of the club since 1919.

In Memoriam

To Mrs. Proctor and to the members of the Class of '17, we extend sympathy from the Class of '21 on the passing of C. Dix Proctor, Secretary of the Class of '17.

On behalf of the Class of '21, we also express to their families and dear ones our profound sorrow on the passing of three members of our Class.

William Daniel Morrison, retired Lieutenant Colonel, U.S. Army, of 69 Star Lake Dr., Pensacola, Fla. 32507, passed away on February 16, 1969, at the U.S. Naval Hospital, Pensacola. A native of Jackson, Miss., he was associated with us in Course I. At M.I.T., he was a member of Sigma Chi. During World War I, he had been a second lieutenant in the Officers' Provisional Training Battalion, Plattsburgh, N.Y., and also served in the Replacement Camp, Camp Grant, Ill. He later earned the B.A. and B.S. degrees after leaving the Institute and was associated with the Morrison Coal and Cement Co., Jackson, until just before World War II, when he returned to Army service as a lieutenant colonel. He was variously construction officer, Quartermaster District I, Charleston, S.C.; tactical and operations inspector, Army Air Force Engineering School, Ft. Warren, Wyo., and post engineer, Camp McCoy, Wisc., retiring in 1960. Surviving are his wife, Mrs. Katherine J. Morrison; two sons, William, Jr., and Robert, and a

Richmond S. Clark, '21 (right), receiving the Houston Yacht Club's award (see p. 122).

daughter, Mary.

Arthur Nelson Doolittle, of Stony Creek, Conn. 06405, died on August 5, 1969. He was born in Meriden, Conn., and was associated with us in Course XV. At M.I.T., he was a member of Kappa Sigma. He had been an engineer with the New York, New Haven and Hartford Railroad.

Stewart Percy Coleman, of 365 Barrett Rd., Cedarhurst, N.Y. 11516, died at his winter home in Houston, Texas, on November 13, 1969. He had retired in 1961 as vice president and director of Standard Oil Co., New Jersey, after 41 years in the oil industry. Surviving are his wife, the former Miss Jane Cochran of Houston, Texas; two daughters, Margaret and Mrs. Theodore S. Hirtz; two brothers, Ralph and Charles, and two grandchildren. We are indebted to Sumner Hayward and to Richmond S. Clark for keeping us informed. Rich writes: "Stewart P. Coleman was best man at our wedding on May 27, 1927. He and I worked on vacuum distillation of lubricating oils under Dr. Lewis at M.I.T. during the summer of 1922. Until he left Baytown to return to M.I.T. for the doctor's degree, he and I were roommates in the company dormitory. He was a member of the committee which Jim Killiam, '26, set up to raise funds for the Lewis Professorship in chemical engineering."

Memoranda

Hope you enjoyed reading the letter from Philip H. Peters, '37, President of the Alumni Association, and proudly perused the complete coverage of the situation at M.I.T. in the *Review*. We're most favorably impressed by the sharp increase in the number of local high school seniors referred to us for interviews this year as prospective M.I.T. freshmen next fall.

This is a sincere invitation to you and your wife to be with the Class of '21 at Homecoming '70, June 14 and 15. And we certainly hope you will set aside the dates of June 10 through 14, 1971, for the all-important and once-in-a-lifetime golden anniversary of the Class of '21. If you live at a distance, please start now to make inquiries and travel arrangements. Can we help you? Please write—we need your news, too.—**Carole A. Clarke,** Secretary, 608 Union Lane, Brielle, N.J. 08730; **Edwin T. Steffian,** Assistant Secretary, Steffian, Steffian and Bradley, Inc., 19 Temple Place, Boston, Mass. 02111; **Sumner Hayward,** Assistant Secretary, 224 Richards Road, Ridgewood, N.J. 07450

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Your Secretary will tell you the Good News of receiving Christmas cards from Carlys and **Frank Kurtz** of Delray Beach reporting their travels to the south including Rio, Iguassu Falls and Bogata—and to Connecticut visiting children and grandchildren; and from Madeline and **Parke Appel** reviewing their pictures of Vienna, Budapest, Dubrovnik and Salzburg; and others in their retirement hideaways. **Dale Spoor** has been forgiven for his Richmond reference to Buffalo's snow because of our lack of snow while reading the Christian Science Monitor and looking at **Jim Hughes'** pictures of snow struck (stuck) Boston at Christmas. In Buffalo we complain because machine-made snow surfaces our ski slopes while Albany, New York and Washington have a remarkable surplus of the downy white flakes. Here in January we are still living up to the enviable reputation of "Sunny Old Buffalo."

George B. Bailey of Long Boat Key, Sarasota, Fla. has written of his compensations found in retirement: "Like Don Quixote, I find interest in keeping banging away at the economic ills that beset us to no avail but I try not to let it frustrate me. Nixon et al seem to be intent on beating Hoover's record in putting us on the economic skids, or so I think. It's too bad that this sort of thing has to be done by the Republicans. . . . Some of our classmates seem to be much perturbed about the student demonstrations at M.I.T. but, I am inclined to be sympathetic with them or at least, their aims. There was an excellent article in *Time* magazine, about three weeks ago, which told about what Howard Johnson has accomplished and was aiming to do and I am all for it. Every Tech man should have read this for it would make them realize what an excellent president we have at M.I.T. and how well he has handled the situation." George feels that Orange, Conn., is a good place to be at any time of the year and therefore he will not make Florida his permanent home. There are too many elderly people around—especially widows.

George enclosed a letter from **Werner Schoop** of Zürich. Werner is enjoying the finest wines while complaining about his deteriorating ability in golf, skiing and billiards. He says that his wife "Hazel's worst complaint is me." He has given up his thirty year job as Honorary Secretary for Switzerland but is still a leader in M.I.T. affairs for the area. They still do some skiing from their house in the mountains during the winter to keep in shape for our get-together at the 50th reunion. Perhaps they will even join us this year on June 14-15 at a table in Symphony Hall with pink champagne and Arthur Fiedler.

Our big thrill was the anticipation of and planning for **Earl H.** (Buck) **Eacker**'s surprise birthday party December 13 on Beacon Hill. Mrs. Eacker ("Peter") had secretly invited friends for cocktails at the Woman's City Club including boyhood playmates as well as M.I.T. and Annapolis classmates. She even used a friend's home to receive replies so that the secret was intact when Buck walked in to the party that Saturday evening. He was greeted by the Appels and many of our classmates including Bob Tonon, Ab Johnson and others. We called him from our Twentieth Century Club Ball to hear sounds from the party like a New Year's celebration. Congratulations were offered and best wishes from the Class. Jubilant and excited, Buck sounded younger than ever.

We have received notices of decease and send the sympathy of our Class to Mrs. **Francis G. Wells,** of Sarasota and the families of **Frank H. Russel,** Needham; **Andrew S. Lapenta,** Wethersfield, Conn.; **Earl M. Kilgore,** Potosi, Mo.; **Platt C. Benedict,** Glendale, Calif.; **Stanley M. Ryerson,** Belmont Mass.; and **Frederick C. Paul,** Palatka, Fla. Andrew Lapenta's sister has told us that he had been quite ill for many months but had hoped to recover to attend our 50th reunion.

And now your Secretary and Roommate go to Ft. Lauderdale for two weeks of sun and relaxation while thinking of new jokes for class notes.— **Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 45 Gerard St., Boston, Mass. 02119

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The column will be short this month so I feel I must set an example by padding

out the copy with some news from Secretary-Treasurer **Thomas Rounds**. Having finished my contract with Aeronautical Systems Division of the Air Force (an updated specification on Instrument Ball Bearings), we are off to spend the holidays with my son and family in Los Angeles. Next spring we are taking off again on a 32-day tour of Japan, Taiwan, Philippines, Hong Kong, Thailand and Singapore. Will see Japan's EXPO '70 in Tokyo on the way. Retirement isn't so bad as I keep active when not consulting in a variety of volunteer activities of civic, church and Rotary nature. Decided to eschew the blandishments of Florida and similar mild climates and stay around the New England "rockpile" for a few years more in this rapidly changing New York Metropolitan exurbia.

We have a note from **Forrest Lange** following the death of his wife Esther in October. (See *Technology Review* class notes, January 1970 issue). He says, "We had a very happy time at the 45th M.I.T. Reunion in 1968 and had planned to attend Esther's 50th Reunion at Gorham State College in 1969 but her illness intervened. I visited my niece in Rochester, N.Y. in November and attended her daughter's wedding.

"Both my niece and her husband were M.I.T. graduates in 1947 and he is presently project engineer for Kodak on the Lunar Orbiter. It is my hope to be back on deck in 1970. In the meantime I appreciate the many expressions of thoughtfulness, kindness and sympathy extended to us in this most difficult period."

We have received belated news of the passing of **George R. Johnson** of East Hampton, Conn., on May 20, 1969. We extend our sincere sympathy to his family.—**Thomas E. Rounds,** Secretary-Treasurer, 4 Deer Hill Dr., Danbury, Conn. 06810

24

The end of the year can always be depended upon to provide a certain amount of news via the Christmas card route. This year was not quite up to previous standards, though. We are most appreciative of all the greetings received, but we could have wished for more of those little personal notes, the stuff of which these columns are made. We might even make a suggestion that this kind of communication is most welcome at any time of year, not just Christmas.

Why not make a note to celebrate Patriots Day, St. Swithins Day, or Susan B. Anthony Day by sending your secretary appropriate greetings? In the meantime, here's the news at year's end.

At the reunion **Mark Sinnicks** said he hoped to be able to get to their California camp high in the mountains by July 1. Don't know whether or not the snow was out of the passes on schedule, but he evidently made it at some time. "Spent most of the summer reroofing our summer place and making various other repairs necessitated by storm damage last winter. Never a dull moment—but lousy fishing. Had a visit from Millie and **Scoop Reinhardt** in September. He's busy in Santa Barbara but can be enticed away on occasion. He and I roomed together in Nichols for two years. Also saw Dr. and Mrs. **Mal Finley** at the fall meeting of the M.I.T. Club in San Francisco. No other '24 types there that I saw. Interesting session with Dr. Lettvin as the speaker. Looking forward to No. 50." Hope Mark can convince the Reinhardts and Finleys to come with him—as well as any other '24 types he runs into.

Jocky and **Phil Bates** put in what they call a volcanic year. In April they were in Oregon where they passed Mt. Lassen and drove up on Mt. Shasta between twenty foot walls of snow. They failed to add to their list at Bald Peak in June, the White Mountains being notably unvolcanic, but in November on their way to Guatemala City they flew near many, at least one of which was still smoking. A bit later, in Antigua, they looked out of their hotel window directly at a beautiful tropical green cone named Agua. Not all their time was spent volcano-watching, however. There was a bit of consulting here and there, some scrambling over Mayan ruins in the jungle at Tikal, and a colorful market day at an old Indian village with the tongue-twister name of Chichicastenango "where the church was built in 1545." Then there were trips to be with children in various parts of the country, all adding up to so much time away from home that the orchids suffered from neglect. Son Charles says they are "behind" in their retirement.

One of the highlights of the Bates's year was a surprise 40th anniversary party at their son Brad's. Jocky described it as being "big," but it probably couldn't compare in size with the **Paul Cardinal**'s, also a surprise party engineered by their children. This was in June, a couple of weeks after reunion. Paul and Lorene thought they were going out to a cozy little dinner celebrating the wedding anniversary of daughter Carolyn and her husband of a year. Imagine their surprise upon walking into a nearby restaurant to discover all eight of their children with their wives and/or husbands, three grandchildren, members of their 1929 wedding party, and a clutch of close friends. Correction: daughter-in-law Gail was absent. She was still in the hospital after having the 23rd grandchild. Some of the younger Cardinals flew in from points as distant as Texas and California. We have no head count, but it must have been considerable. Entertainment was provided by Ed Murphy, '25, ". . . Paul's best man and fraternity brother [who] volunteered with songs and ditties from their days at M.I.T." Wonder how the younger generation responded to such rollicking lines as "I'll shun the physical quizzical profs, and chapel and all tha-a-at . . . "

Nish Cornish used that Sunday night cocktail party last June to good advantage, or maybe it was Luisa who turned on the charm. In any event, they persuaded the Killians to be the guests of honor at this year's Mexican Fiesta. "Seems impossible, but I guess it's true. Our 1970 Fiesta is the 22nd Annual." The Killians have been there before, so it probably didn't require much of a selling job.

M.I.T. Homecoming (Alumni Day), is June 14 and 15 this year; Arthur Fiedler will once again be featured, but with a difference. This will be a night at the Pops (June 14) as you remember it, the tables at Symphony Hall, popping corks, pink champagne, the works. Six months before the fact the committee (still called the Alumni Day Committee) began exhorting us secretaries to prod our respective classes to respond promptly, the penalty for late responders being banishment to the balcony. There's probably nothing you can do about it before you get your first reservation form, but by that time our prodding should have whipped you up to fever heat so that your response will be immediate and positive. Consider that you have had your first prod.

Sorry to have to report three deaths. Last June **Clarence. P. Sullivan** died in West Virginia. He was a Course XV man who became one of the top management in Fostoria Glass. You may remember him as "Spud." In October **Francisco de la Macorra,** died in Mexico. And in November **Francis V. Storey** died on Cape Cod. Frank had been with department stores both in Boston and Providence, and was at one time president of the N. E. Housewares Club. He had evidently gone into business for himself, for the newspaper notice described him as a "prominent dealer in glass and chinaware." Frank was in the Navy during W. W. II, a lieutenant commander at war's end.

So much for now. The news next month will be . . . SPRING!—**Henry B. Kane,** Secretary, Box 177, Lincoln Center, Mass. 01773

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In the last month, your secretary has missed meeting two members of the Class who dropped by M.I.T. on the work days which now in my retirement I spend on Cape Cod. **Masaru Kametani** dropped by to say hello and left word that he was spending the night with **Arthur Odegard**; and **Eugene Hermann** tried to get in touch with me by telephone. The message I received from Gene was that he and his wife are planning to attend the 45th reunion next June. If you have not responded to Ed Kussmaul's letter by now, please do so, so that Ed and his committee can get their final plans formulated.

Since the last *Review* notes were prepared, word has reached me of the deaths of a number of classmates. **Ernest C. Greenough** passed away in Waltham, Mass. on August 26, 1969; and **Richard J.**

Pitman died at Laconia, N.H. exactly one year earlier, on August 26, 1968.

Alfred K. Morgan who ran the Palisades Interstate Park in Nyack, N.Y. died on October 15, 1969. He had built the world's largest park adjacent to a large city, and had retired from his post as General Manager of the Palisades Interstate Park Commission only on October 1. He had worked closely with planner Robert Moses and one of his first assignments was the designing and building of the parkways for the Long Island State Park Commission. He was the designer and builder of Jones Beach on Long Island, and later built beaches at Lake Sebago and Lake Welch in the Bear Mountain State Park, described as the largest inland beaches near any metropolitan area. He was one of the leading designers of the 1939 New York World's Fair, planning the New York City Building, the New York Amphitheater, the Lagoon of Nations, the fountain lake show and other water and light displays.

Another death to report is that of **George A. Nelson** who passed away in Berkeley, California on November 8, 1969.

In reading the M.I.T. Treasurer's report for the school year 1968-69, your secretary found among the gifts a bequest from the estate of **Henry G. Bacon.** This was the first information regarding his passing, and I know many of you who have attended alumni banquets in past years will be saddened to know that Henry will not be there to enjoy clam chowder on future occasions. Although the Treasurer's Office had information regarding the bequest, the actual date of Henry's death was completely missing. After contacting the lawyer who was handling the estate your secretary found that Henry passed away two years ago, on December 29, 1967.

In the January *Review,* I reported that **Roger Ward** had dropped in at my office, again in my absence. A letter from him received a few days ago indicates that he is leaving New Orleans in February for a trip around the world on a Dutch freighter, the M.S. *Karakorum,* and he will not return until some time in July. It had been his intention to join us for our 45th reunion. He now says he will sign a written guarantee that he will make the 50th and will not even put a force majeure clause in it! He notes that he is enjoying pursuits which have little to do with mechanical engineering, and for the past few months has been retained by a group of investors to show them how to make a profit out of a bankrupt Carolina mountain. He goes on to state that although this may sound a little more peculiar than some of his other detours from conventional engineering, he is convinced that the same systems technology which successfully took Apollo 11 and 12 to the moon and back can be applied to many of our lesser problems here on earth, so he has undertaken to make a molehill out of a mountain.

A news clipping from the *Free Press* of Melrose, Mass. noted the testimonial dinner given on October 23 for **Arthur O. Odegard** upon his retirement from the Massachusetts Department of Public Works after forty years of service. Before joining the Massachusetts Department of Public Works, Arthur had served as construction engineer with the Aberthaw Construction Company and as street engineer with the city of Lynn.

Two address changes have come in during the past month and are of more than passing interest to your secretary. **Robert O'Hara** is now in Miami, Fla., and I wonder if this means retirement to that location or simply a winter visit. How about a little more information, Bob? **Kenneth Proctor** sent in an address change noting that he is now located at 96 Quartermaster, South Yarmouth, Mass. I expect Ken has retired to good old Cape Cod, and this makes him one of my neighbors. If he journeys over toward Chatham, I hope he will look in on me. If he does not, I will catch up with him sooner or later.—**F. L. Foster,** Secretary, Room 4-144, M.I.T., Cambridge, Mass. 02139

1970 Alumni Fund	Class	Donors	Per Cent	Dollars
	1921	132	29	$36,631
	1922	184	31	97,768
as of	1923	159	30	169,152
	1924	165	35	20,374
	1925	143	31	25,553
January 27, 1970	1926	193	36	27,791
	1927	150	31	23,720
	1928	153	30	17,616
	1929	109	22	18,908
	1930	126	24	25,908

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We have elected to write the March notes in our study down away from the distractions of the ocean.

George Makoroff took the opportunity of expressing himself about pink undergraduates on his Christmas card—and who has more justification? (George came to M.I.T. from Odessa, Russia).

Another communication in a Christmas card came from **Martin Staley** in San Antonio: "Dear George, Christmas Greetings from Texas and the Class of '26 M.I.T. I certainly enjoy the *Review.* I have a large photograph of the '56 (our 30th) reunion which I have decided to send you since I arrived at the reunion a day late and was not in the picture. I have not retired—as I remember you have. This month I received my first social security check . . . I was 72 in November—another milestone passed. I retired from the Army Reserve Corps of Engineers over 12 years ago, with pay. Best regards and wishes. Sincerely, Martin."

The usual seven-page printed booklet came from **Crockett** ("Dave") **Harrison** of Grove City, Pa. Dave's volume brings us up to date on his vast family and also about his retirement traveling to which he refers in a note. "Dear George: Before going to Hawaii I intended to write you for the address of **Bill Forrester.** I knew from your notes and a chance meeting with Bill at the Newark Airport a year or so ago that he had a place in Hawaii. Upon our return I found a *Technology Review* that mentioned Bill and gave his address in Hawaii. We were in Labaina many times so I am sorry we did not get the address before leaving. We hope to go to Australia and New Zealand in February. Sincerely, Dave."

John Longyear continued his herb-containing Christmas card with a packet of sage from their garden. His address is still Dearborn, Mich. . . . We had a real windfall from **Chet Buckley** in early December. As a matter of fact his letter was so good that we plan to save it for next month since it will give us a good backbone for the issue. . . . Others who sent greetings to the class were **Argo Landau** from St. Louis, **Howard Humphrey** from Wilmington, Del., our class president, **Dave Shepard,** and of course **Jim Killian.**

We just went upstairs and one look at the sea tells us it's time to quit. The sun is out and the sea is sparkling, with clean dry snow down to the shore line—and we have a new camera to try out—so until April, Cheerio.—**George Warren Smith,** Secretary, Pigeon Cove, Mass. 01966

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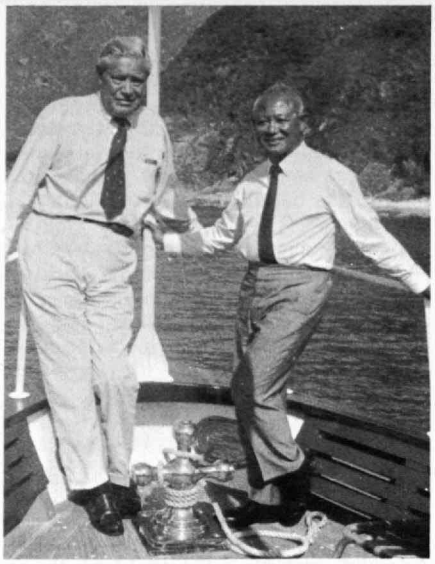
Spurred on by a letter from **Erik Hofman,** I looked back in the files and find that Erik and **We-Tuh Kwauk** have been having a game of you-come-to-my-house/I-go-to-your-house. Erik saw We-Tuh (Wally) in Hong Kong in 1962; and in the winter of '66-'67 Wally was en route from Hong Kong to London and stopped off to see Erik and Tibby in Mallorca; now comes this word from Erik: "Your wandering classmate reporting and enclosing evidence. Picture was taken on Wally's boat—anchored for lunch in a cove in Hong Kong harbor. Tibby and I are mak-

Mr. and Mrs. David R. Knox, '27



Erik Hofman (left) and Wally Kwauk of '27

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ing a round-trip from Marseille to Hong Kong and back—but while Tibby came around Africa, I flew to Kenya and had a grand two weeks on safari, photographing wild animals. It was really an unforgettable experience."

A new report on **Dave Knox;** Dave has written the following interesting note: "I have been writing a manuscript in my retirement about our experience with aphasia. I learned in November that it had been accepted for publication by the Wayne State University Press. Dorothy had her stroke in 1964 and she was left (at the time) with no speech capability. She has made such satisfying improvement, although by no means a complete recovery, that I thought that the story of our experience might help others similarly afflicted. There seems to be a void in the literature devoted to the impact on the spouse and family. It will be several months before the book goes to print." Dave asks about **Jim Lyles** and I am glad that I can send him a good report. I think probably that these two will be writing each other. One can only have the greatest respect for an undertaking of this kind.

We regret to report the death of **William F. Bingham** on October 3, 1969, in Portland, Ore., where his home was at 1835 S.E. 32nd St. After receiving his S.B. in civil engineering Bill began his long career with the U.S. Army Engineers, serving first on the west coast. In 1949 he went to Caracas, Venezuela as an engineer consultant to work with the Ministry of Public Works on an extensive program of irrigation projects. His specialty was dam design and construction. Returning to the States two years later, he resumed his work with the U.S. Engineers in the Middle West and in 1966 he moved to Portland.

In New York, **Bob Bonnar** and **Anson Rosenthal** drummed up a 1927 lunch at the Chemists' Club on December 2. Under the careful urging of Bob and Rosie all present sent a note to bring us up to date. Just a line apiece but full of interest, it reads as follows: "**John O. Collins:** Retired four years ago from Esso Research. Enjoying it immensely and traveling in Europe plus summers in Maine. **John B. Drisko:** Still trying to get that dam in Pakistan built. (This isn't surprising as John has previously mentioned that it is the biggest in the world.)

Edward T. Dunn: Retired four years now. Still keeping bachelor house and enjoy driving around in a 1969 Riviera. **H. W. Fisher:** Retired October 1, 1969. Busy at the Community Blood Council. Dealing in pints instead of barrels. (We all know Bud is doing a few other projects. I have an excellent article by Bud, "Innovation in a Large Company" but have been trying to find out where it was published or, if a speech, where delivered.) **Raymond F. Hibbert:** Still in New Canaan. Jim Lyles probably told you we met for lunch in London, England. Still a manufacturers' representative—all's well. **Gordon C. Jacoby:** Going south Sunday after Christmas. Glad to miss the snow. **Joseph H. Melhado:** My first grandson arrived on Thanksgiving morning—Thomas Joseph Jacobs. Now I've joined the Club. **Harry J. Moser:** Retirement coming in 1971. Let me know how the others feel about it. (Those who write me about it all say it's fine.) **Frank C. Staples:** Just returned from Rio on a visit to my married daughter. Still going—no intention of retiring. (I keep asking my kids to live someplace interesting to visit. So far no luck.) **Russell P. Westerhoff:** Still working and not going to retire until early 1972." (Russ—Hate to put you alphabetically at the end. I understand that there is serious research to show that this becomes depressing. Hope not!)

Looking at the Notes of 25 years ago, I read—unbelievably—that "**Bob Bonnar** has undertaken to organize a get-together of class members residing in the Greater New York area." So history repeats itself!—**Joseph S. Harris,** Secretary, Box 654, Masons Island, Mystic, Conn. 06355

The response envelopes for the Alumni Fund provide space for your personal news in Class Notes. Such news items, though generally brief are very welcome so please respond and use the note panel. Here is the yield for this month: **Henry LaCroix,** who is with Foster-Wheeler Corp.: "Spent considerable time in Europe and Middle East this year, Italy and Sicily, Yugoslavia, Spain, England, France, and Kuwait. As Senior Consultant on Process Plants Designs and Development have had interesting experiences."

Desmond Shipley: "We had a chance to re-visit New England in August. We sailed from Norwalk to the Thimble Islands (Pine Orchard Y.C.) and then past the locale of our fifth reunion at Saybrook and up the Connecticut River to Essex, a charming little town. A nice breeze took us into Stonington, R.I. in time to row ashore and get some wonderful live lobsters. We managed to cook them on a small galley by throwing the forward carcass away and just cooking the tails and claws. Winds still held and so up to Block Island, to Cuttyhunk and then to Edgartown. The Edgartown Y.C. launch service was terrific. My wife and daughter biked to the Dyke Bridge which seemed the thing to do." . . . **George Mangurian:** "Promoted to Manager, Northrop Support Operations Department of Electro-Mechanical Division of Northrop Corp. on August 26, 1969. Also appointed Vice President and Manager of Northrop Services, Inc., a totally owned subsidiary of Northrop Corp." . . . **Victor Hagedorn:** "Retired on October 31, 1969 after 33 years service with U.S. Government. Last assignment as Chief Engineer for 'JUSMG-MAAG Spain', where I spent the last 16 years. Plan to make my address and residence here in Madrid at Box 902, 401 CES, APO, New York 09283. All M.I.T. Alumni welcome always!"

Charles Topping: "Although I went to my retirement party in August, I am still working for DuPont as a consultant full time at a most interesting job." . . . **Victor Decorte:** "Alice and I returned yesterday from the U.S.A. where we visited relatives in Cape Cod and Winthrop, Mass. We had a wonderful stay and a most enjoyable round trip on the *Michelangelo* and the *Raffaello* of the Italian Line. Will spend the winter in Rome, a beautiful city with a delightful climate." . . . **Robert Tucker:** "Even though retired, I hope to be around for some time yet to enjoy and marvel at the current accomplishments of mankind!"

We have had a note from **Newton Foster** for some time and must apologize for not getting it into the news before this. Newton is Project Administrator for Congoleum Industries (formerly Congoleum-Nairn, Inc.) Division of Bath Industries, Inc. He expects to retire early in 1971. With wife, Olive, Newton has traveled in Europe. Last summer it was England, the summer before it was Norway, Sweden

and Denmark, and the summer before that Portugal and Spain. We know that Newton has given much of his time and energy to Institute related activities, including: more than 25 years as Honorary Secretary of M.I.T.; service as Chairman of the Northern New Jersey Educational Council; the interviewing of over 120 applicants for admission to M.I.T.; past service as President of M.I.T. Clubs of Northern New Jersey; work on Mid-Century Fund, Second Century Fund, and other fund drives.

Al Gracia, one of our highly distinguished classmates, made the local news (Cambridge, Mass.) recently. At the 74th Annual Reunion of the Rindge Alumni Association (Rindge Technical High School), Al was honored as "Rindge Man of the Year". The award was made before an attendance of over 400 members of the association. Al retired recently as Vice President of Research at Goodyear Tire and Rubber Company, Akron, Ohio. He started with Goodyear directly from M.I.T. and had an outstanding career.

A press release of November 24, 1969 from Corning Glass Works announced the appointment of **Thomas S. Wood, Jr.** as Assistant to the President. Quoting from the release: "Wood joined Corning in 1928. He has served in a number of positions in manufacturing, sales, and purchasing, including Manager, Pressware Plant (1938-41), Manager of Lamp Sales (1946-57), and Director of Purchases (since 1957). He was elected a vice president in 1961."

In a letter to **Jim Donovan,** "Bill" **A. A. Archibald** wrote: "Congratulations to Ralph Jope's son Teddy on his graduating from Cornell. Our second son, Roger, went their for a year before enlisting in the Navy. He took a four-year enlistment in the Navy and is due to be mustered out January 1970. It has been a tremendous experience for him but the price in time at this time of life has been very high. Yet all we can do is hope that he returns safely and help him get a fresh start on his education." Bill, who is Administrative Vice President for Jones and Laughlin Steel Corp., Pittsburgh, Pa., expects to retire in 1970 after 35 years with his company.

Now for the final installment of that beautiful long letter from **George Bernat** on his travels with wife Ruth: "1968: We toured western U.S.A. and visited parks and places of interest that we had not seen previously. We covered about 8,500 miles on this trip and saw some of the most beautiful scenery we have ever seen. For sheer beauty there is nothing that beats our national parks, the Rockies and southwestern Colorado.

"1969: We made a short quick trip to the Scandinavian countries. The fjords in Norway are very beautiful but I prefer our national parks for scenic beauty. It is interesting to visit the various countries. Each is different, the people are different, and the customs and standards of living vary.

"Prices are very high in Sweden due to the welfare state and Stockholm is like New York City. Norway is charming in every respect. Finland is interesting but one feels sorry for them because they are still paying reparations to Russia. Denmark is a cross between Sweden and Norway."

It is with sadness that we must report the death of **William D. Birch,** December 3, 1969, in Boonton, N.J.: As reported in the Newark *Evening News* of December 4, 1969, Bill was born in Dover, N.J. in 1903 but lived in Boonton the last 32 years. He was prominent in State Republican activities and served in various important posts including delegate-at-large to the National G.O.P. Convention in San Francisco in 1956. He was one of the early organizers of support for the candidacy and election of Dwight D. Eisenhower in 1952. Until retirement in 1965 he was a partner in the Birch and Birch Cadillac Agency, Inc. In addition to business and political activities, Bill held various positions of responsibility in areas of civic service. Besides his wife, Helen, he leaves three sons: Christopher H., William D., Jr., and G. Ross; a daughter, Mrs. H. VanLeigh Gorman; a brother, Foster F.; and four grandchildren.—**Walter J. Smith,** Secretary, 209 Waverly Street, Arlington, Mass. 02174

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I have received a letter from the widow of **John H. Foster** whose death was reported in the February issue of the *Review.* Mrs. Foster writes: "Appreciate sincerely your kind note of sympathy on the sudden death of my husband, John, . . . on May 3. He was happy in what he was doing, enthusiastic about American Can's plan to move to exciting new headquarters in Greenwich, Conn. We had almost 38 happy years together, and a wonderful family. This summer, my nice children helped me move into a condominium apartment in Heritage Village Housing in the Connecticut Hills, an unbelievably beautiful experiment in living for older but active people. This was one of the places John and I had considered for retirement. Sincerely, Marion S. Foster, 168A Heritage Village, Southbury, Conn. 06488."

On December 4, the Reunion Committee met at the M.I.T. Faculty Club for an informal get-to-gether at which time movies taken at Wianno last June were shown. Needless to say, it turned out to be an all fun meeting, so much so that it was suggested to have more of the same. Among those present were: Helen and **Hugh Hamilton** who delayed their scheduled departure to their winter home in Florida in order to attend. We learned also that the Hamiltons had a wedding coming up in December. Their daughter Joan was getting married in Florida.

Frank Mead, our new Class President and his wife Mary naturally attended although there was very little need for a presiding officer—fun and informality was the prevailing mood.

It has been said that there is a woman behind every successful man. Frank can boast of having two such women, his wife Mary and his secretary, Miss Louise McLaughlan. It was revealed that night that Miss McLaughlan had done a tremendous behind-the-scenes job of letter-writing and cross-country telephoning during the reunion campaign. As a gesture of appreciation, a unanimous resolution was passed to make Miss McLaughlan an honorary member of the Class of '29 in recognition for her invaluable services rendered to our class activities.

John Rich and his wife Olive were also present at the meeting, traveling from Nashua, N.H. for the occasion. John confided to me that his wife actually should have received some of the credit for such good reporting as she had been doing most of the work. I have a feeling that John's secretary also gave him a hand once in a while, letter-writing, etc. The Riches informed me that having been liberated from secretarial duties, Olive has enrolled in an art course at Radcliffe which prompted her to accompany John to Italy last summer on a business and pleasure trip. They said that the first week was devoted all to business, and the next two, they visited every cathedral and sacristry in northern Italy. They had such a wonderful time that, as MacArthur said, "We shall return." John is currently president of Improved Machinery, Inc. (a subsidiary of Ingersoll-Rand).

Others who were present at the meeting were: The **Arnold Contis**: "Let us have more mini-reunions. No more pregnancies since Wianno. Like the guy says, you don't raise children any more—you finance them." . . . The **Ted Malstroms** reported the arrival on October 30 of their first male grandchild, Keith Douglas Thompson. . . . The **David Wilsons** report: "No personal news—only more grandchildren." . . . The **Joseph Speyers**: "Great to have these informal gatherings. Let us have more of them." . . . The **Wally Gales**: "My feelings are expressed precisely by the famous business card being circulated which reads—'Elmer Skonberg, Retired—no business—no phones—no worries—no prospects—no money—just having a good time.' "

Others present were: the **Paul Donahues** and daughter, the **Joseph Greens**, the **Bill Baumruckers**, the **Edward Farmers**, **Charles Frank,** the **Jerry Gardners**, the **Herman Meissners**, the **Karnig Dinjians**. Candid pictures taken at Wianno have all been sent to those who ordered them. If you have not received your order by now, please let me know. With kindest regards to you all.—**Karnig S. Dinjian,** Secretary, 32 Oldham Rd., Arlington, Mass. 02174

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By the time these Notes appear you should have received at least a first mail-

ing and perhaps a second mailing concerning our 40th reunion on June 12-14. Jack Latham has been making a considerable effort to ensure a good attendance. In late December he sent out "work kits" to selected men from each course with the idea of setting up a network that would establish personal contact with most, if not all, members of the class. His system has a built-in feedback which, as of the date of his letter (mid-January), indicated that at least a fourth of the active members of the class would receive a personal pitch. Please send in your reservation and registration fee promptly so that your reunion committee will be able to plan effectively and will have the funds necessary to cover pre-reunion expenses.

Those of you with good memories may recall that in the February 1965 Notes we reported that **Vince Thormin,** who was then working as an architect for Aluminum Co. of Canada, had decided to study for the ministry and was taking night courses at United Theological College, McGill University. Vince now reports that he completed his theological studies and for the past three years has been an ordained minister of the United Church of Canada. He has a "two-point charge" in a rural area and lives in Goodwood, Ontario, which is about a 45-minute drive from Toronto. He says that his present rural environment "is really wonderful after city life." The Thormins' four children live and work within easy visiting distance. . . . **Bill Spahr** is manager, budget and costs, for Metropolitan Life and lives in Smithtown, N.Y. He is secretary-treasurer of the Smithtown Boosters Club and says he still plays some golf. The Spahrs have two daughters and a son. Second daughter Lucia works for the Sloan Fellowship organization at M.I.T. . . . **Allan Stone** has retired to Elkhart Lake, Wis. but still does occasional management and/or engineering consulting work. He is active with Road America (sports car racing). The Stones have two married daughters and three grandchildren.

Three classmates reported this month that their activities have not changed since we last heard from them in 1965. To refresh your recollection, **Godfrey Thomson** is an engineering draftsman with Colorado Fuel and Iron Corp. in Pueblo, Colo.; **Helen Lustig Thornton** is teaching mathematics at Brewster High School in Brewster, N.Y., and has acquired a three-year-old granddaughter, Dawn Marie Zaminello, since her last report. **Clyde Tirrell** is an electronics engineer (shipboard communication antennas and systems) at the Naval Electronics Laboratory Center, San Diego, Calif.

The November 29, 1969 edition of the *Washington Evening Star* carried a picture of **Haskell Small** about to begin eating. Haskell is active in the Washington Opera Society which on November 29th arranged a musical program for its patrons that included a duet by Eleanor Steber and Blanche Thebom "hamming it up" with their version of "Bosom Buddies" from the Broadway hit "Mame." After the musical program Haskell sponsored a reception and buffet at the Washington Arts Club. . . . **John Pratt** writes that he had the misfortune to "pick up" a cerebral-vascular accident in January 1969. He says that he has pretty well recovered but that it has slowed him down some. He is trying to complete his tenth year as Finance Chairman of the Hancock County (Maine) Republican Committee. . . . We have at hand two items concerning **Norman Dolloff** which are essentially unrelated and yet have a common thread. The first item is the "News for my class secretary" portion of his Alumni Fund envelope wherein he indicates his unhappiness at not being able to contribute more to the solution of the problems of the minorities—Blacks, Chicanos, Indians, etc. and his pleasure at the change in philosophy at M.I.T. since the "old days." The second item is a clipping from the *San Francisco Chronicle* that **Howie Gardner** sent me reporting that Norm recently resigned from the prestigious Commonwealth Club with the following rather acidic comment: "I am interested in conservation—the Sierra Club does more; I am interested in our environment —Save the Bay does more; I am interested in population control—Planned Parenthood does more. Carry on, lads, I have important things to do!"

Ed Hawkins has been elected a senior vice president of Stone & Webster Management Consultants, Inc., New York. . . . Certificates of Appreciation for their work in connection with the 1969 Alumni Fund have been awarded to **Ralph Peters,** Rochester Special Gifts Chairman, and **Haskell Small,** Washington, D.C., Regional Chairman.

It is regretfully necessary to report the death of another of our classmates, **John L. Vennard,** who was Professor of Fluid Mechanics at Stanford University and one of the leading experts in his field. Jack died of a heart attack at his home in Palo Alto on December 27. He had been a professor at Stanford since 1947, was the author of standard texts in his field and a consultant in such fields as dam design and space flight mechanics. He was a longtime chairman of the university's Faculty Advisory Committee to the president and was faculty representative on the Board of Athletics. He is survived by his wife Dorothy and two daughters.—**Gordon K. Lister,** Secretary, 530 Fifth Avenue, New York, N.Y. 10036

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Paul Semple writes that after some 27 years of U.S. Government service he retired from the Renegotiation Board early in 1969. He seems to be enjoying retirement by traveling (Spain last June), doing tax work and stock market analysis. Paul expects to remain in the Washington area for the next few years. . . . Those walking along the path from Building 26 to Building 20 have been puzzled recently by the addition to the courtyard of a small concrete sarcophagus shaped object just sitting there. Recently, the mystery was unraveled when the sculpture, "Cenotaphe" was installed on its new permanent perch . . . a gift of **Leon Kolker.**

John Swanton reports that his son, Kenneth, has departed for the M.I.T. campus, class of '73. (Congrats, John). Ken has joined the Sigma Phi Epsilon fraternity. John says that this is the last of his tribe—the four others are married. . . . A recent announcement reports that **Parker S. Dunn** is Group Vice President and President and Chief Operating Officer of American Potash & Chemical Corp. . . . In June of 1969, **Nelson Haskell** resigned from his local school board after almost 13 years as Trustee. Nelson is still with Texaco, Inc. as Manager Product Control. His children are no longer dependents and during the past three years he has vacationed in Europe, Mexico and Hawaii. Nelson is looking forward to seeing his classmates at the 40th reunion.

Claude Machen has been elected a director in Baystate Corporation, a bank holding company. Claude has also been appointed a member of the Board of Visitors of Boston University College of Business Administration. . . . **"Aug" Rynalski** writes that he and his wife thoroughly enjoyed a 31-day trip by air around South America last January and February and says that they have been continuously and comfortably busy during six years of retirement thus far. . . . **John Gardner** is still with General Electric Co. as Senior Project Engineer of Real Estate and Construction Operation. He has no complaints but is looking forward to retirement. . . . **Alex Kuhnel** is staff consultant—System Engineering—for the Auston Company in Cleveland Heights, Ohio. He has been most active in various professional engineering societies in New York and Ohio and is interested in the role of engineers in developing solutions to national problems.

Art Fitzgerald who is deputy for management systems in the Office of the Assistant Secretary of the Air Force (Financial Management) made the headlines when, expressing his views in *Professional Engineer,* he criticized the loose acquisition practices and said it was one of our most severe national problems.

Ken Germeshausen addressed a group of EG&G personnel at an interdivisional seminar to discuss remote sensing operations. . . . Congrats to **Lombard Squires** of du Pont whose outstanding contributions to the nation's nuclear energy program gained him an Atomic Energy Commission citation from the National Academy of Engineering.

Our deepest sympathy to **Bill Stellrecht** and his family upon the death of his wife Elizabeth last October. I also regret to report that our following classmates have passed away: **Lincoln Gifford** on March 14, 1969, **Tigris H. Kazandjian** on July 26, 1969 and **Harry R. O. MacNevin** on January 28, 1969.—**E. S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn. 06880

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Jacob Millman, Course VIII, has been professor in the Electrical Engineering Department at Columbia University since 1952. He has written five books on electronics which have been translated into six foreign languages. The most recent are *Pulse, Digital and Switching Waveforms* and *Electronic Devices and Circuits*. Son Richard graduated in 1966 in mathematics at M.I.T. and is finishing his Ph.D. at Cornell. Son Jeffrey is in his junior year in electrical engineering at M.I.T.

Lester Glickman sends an announcement of his marriage in October to Gladys Sternberg of Forest Hills, N.Y. and includes his new address: 400 Bellevue Ave., Apt. 205, Newport, R.I. 02840.

Kenneth B. Thompson, Course XVI, whose address is Box 927, Fallon, Nev., sends a note that he is a part-time rancher and that his wife, Ruth, raises blooded Arabian horses. . . . **Richard L. Morgan,** Course II, who retired as Colonel in the U.S. Army Corps of Engineers, is now a General Engineer at the U.S. Army Mobility Equipment R&D Center, Ft. Belvoir, Va. He has a son and two grandsons living in Maryland. Dick is a stamp collector, golfs weekly and visits the Caribbean Islands annually.

Angelo F. Ghiglione, who took his Master's degree in civil engineering with our class, is Deputy Director of Operations for the U.S. Bureau of Public Roads. He recently won a national engineering award for designing a road through the jungle in Central America to parallel a possible new canal. From 1950 to 1960 he built roads over muskeg and permafrost in Alaska. Angelo and his wife took a trip around the world in October.

Charles B. McCoy, who became the President of duPont in 1967 climaxing a 37-year career with the company, received the Chemical Industry Medal for 1969 at the annual awards by the American Section of Britain's Society of Chemical Industry. The award recognizes "conspicuous service to applied chemistry". In a recent speech Charles stated that the challenge is for industry to place its technological resources in the service of man and to couple its business goals with the clear and pressing needs of society.

I have an address change for **Robert D. Butler** which indicates that he and his wife, Eloise, are back from South America and are living at 730 Edgemere Lane, Sarasota, Fla. 33581.

A report dealing with major problems and trends in the building industry prepared by Professor **Albert G. H. Dietz** for HUD has been made available by the U.S. Dept. of Commerce Clearinghouse, Springfield, Va. 22151. Ordering information is: Document Stock No. PB-185 208 Title: The Building Industry, March 1968, 291 pp, $3.00.

Ray W. Hawksley, writes from Richmond, Calif. that he is deeply involved in water pollution work. He is operating his own independent laboratory and has as clients oil refineries, chemical companies, and food industry companies. Two sons John and Sidney have produced seven grandchildren.

For the past few years **Jim Mackernan,** of Reading, Mass., has been disabled by Parkinson's Syndrome. He writes that recently he has been making progress under the very able guidance of Dr. Albert C. England at the Massachusetts General Hospital. Dr. England is pushing hard against the limitations of previously known treatments; for this Jim is very grateful.

Willard A. Meyer writes that his family has just completed its college program and he is now looking forward to retirement at their place in Lincolnville, Maine. Their educational program consisted of one daughter, B. A., Hollins College; one daughter, B.A., Wellesley, M.A., N.Y.U. teaching and working for Ph.D., University of North Carolina; one son, B.S., Williams College and O.C.S. Navy; and one daughter, B.A., Wheaton College.

Roger J. Zampell writes that he retired in August from the Naval Research Laboratory, Washington, D.C. and has moved to 6540 NE 21st St., Ft. Lauderdale, Fla.

John Griswold has retired and set up an electronics service shop in his home in Convent, N.J. with all the business he can handle in TV, tape recorders, and hi-fi's which he always liked to play with.

Robert Thompson was resigned as president of a division of Dorr Oliver Inc. and is now operating from Wilton, Conn., as an independent consultant. He writes that he is enjoying the transition and should have done it years ago.

A graduate reading room in the new chemistry building under construction at M.I.T. will be established as a memorial to Captain John B. Ford who founded the company that became Wyandotte Chemicals Corporation. The gift for the memorial room was annouced by **Robert B. Semple,** President of Wyandotte Chemicals.

Norman T. Wilson, Course XV, died unexpectedly on November 30, 1969 at his daughter's home in Georgia where he and his wife, Sarah, had gone for Thanksgiving. Norman resided at 1510 Santa Maria, San Jose, Calif. but lived during his school days in Newburyport, Mass.

Edward N. Rosenquist, Course V, died unexpectedly November 18, 1969 at his home, 4624 Silverwood Dr., Dayton, Ohio. At the time of his death he was manager of operations administration in the nuclear department of Monsanto Research Corporation's Mound Laboratory. . . . A recent letter to the Alumni Office tells us of the death of **Dennis J. Curtin,** on July 4, 1968.—**Elwood W. Schafer,** Secretary, Room 13-2145, M.I.T., Cambridge, Mass. 02139; **James Harper,** Assistant Secretary, 2700 South Grant St., Arlington, Va. 22202

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We start this one off, on November 23, 1969, with not much of a bang, and with practically no pile-up of note material from our loyal classmates. Traditionally, this is a poor time of year to get the faithful (?) to write Ye Scribe, but it does not need to be quite so traditional, or, to such a point that only three or four get around to it.

I told **William B.** (Bill) **Klee,** in a note of acknowledgment, that I would use him first this time. Bill and I have commiserated with each other for having missed seeing same at the Alumni Officers' Conference in September. I was forced to leave early, and so missed Bill. I also missed the annual dinner with pre-dinner party at Walker.

Bill always writes a nice letter, and admittedly, not often enough to become offensive! I wish, and wish, that every classmate would write me once a year, even a one-page synopsis. That means that I would be forced to report on about 90 each month. But, this is not to be, and Bill, I appreciate your thoughtfulness, especially at this time of year. Bill is, apparently, quite a lot retired as he says that he is now a consultant for the Whittaker Corp., which took over Damascus Tube Co., less than two years ago. Bill served as Board Chairman of Damascus for six years, following a fifteen-year term as president of same. But, all this does not mean that Bill even tries to put all his time into consulting, as that sure would not be William. He is now the chairman of a rather presumptuous civic endeavor, which will be Avalon Inn, just east of Warren, Ohio, Bill's home town. Inasmuch as the project is civic, we feel free to give it more than a mention in our column. As indicated in a brochure of the Avalon sent to me by Bill, they plan a magnificent club house complex, surrounded by two championship 18-hole golf courses, and every conceivable kind of recreational space.

Bill has also reminded me that his not-too-recently new home in Hilton Head, S.C. is a fine stop-over spot between Florida and the Nawth. Hilton Head also offers two 18-hole golf courses, with homes built all around every hole wherever possible, a fine hotel in the southern tradition, the Governor Hilton Lodge, and a variety of other fine accommodations to fit any pocketbook. Bill says that his name is in the phone book, and he can be easily reached, as he is spending more and more time there during the winters.

Bill's three daughters are all married, and as he says, in rather interesting ways. *Goodridge 25* shows a photo of Margaret and Bill Klee, with their three daughters aged 21, 19, and 17. That was 11½ years ago. The eldest is now

1970 Alumni Fund	Class	Donors	Per Cent	Dollars
	1931	167	30	$34,821
	1932	147	29	24,896
as of	1933	150	29	59,700
	1934	175	33	31,338
	1935	142	30	107,599
January 27, 1970	1936	137	31	24,792
	1937	117	32	13,413
	1938	114	27	15,053
	1939	153	32	10,079
	1940	142	26	17,231

married to a Harvard-London School of Economics-State Department-Peace Corps lad, shortly to take up Berkeley's Institute of International Studies. Middle daughter is married to a Florentine artist, and they are residing there, happily, and (a word I dunno) parsimoniously. The youngest is more (or less) orthodox, married to a "Pittsburg Computor Type." How happy Bill and Margaret must be. Bill, I especially appreciate your fine letter, so concise, effective, and sincere. Thanks a real million Bill, and best to Margaret.

In our last issue we mentioned the passing of **John Carver Gale,** of Lexington. We have since received a fine note and a clipping from John's wife, Sarah. Inasmuch as John did not take a degree at M.I.T. I looked the matter up to see if there were any mitigating circumstances, and there were, for sure. John received his B.S. from Northeastern, then came with us, and did graduate work from 1932 to 1933, but, apparently had no intention of taking a degree. Besides his good wife, Sarah, John is survived by a daughter in Philadelphia, and a son in Marengo, Ill. We repeat our earlier mention of the deepest sympathy which our Class sends to Mrs. Gale.

I have a brief note from Eleanor Winters from which I quote, "I am sure that there are not, and cannot be, many classes of M.I.T. Alumni represented as is the Class of 1933; with not only miles separating you from Bob's life, but even an international border, . . . still you were there paying tribute so faithfully, and demonstrating the goodness and humanity in that huge institution. . . . [The people of Lunenburg] are glad to have Bob's grave there, and I am so touched that you saw the lovely spot. . . . Love to you both, Eleanor." I submit that the above is a fine tribute from the widow of one of our finest. Thank you, Eleanor, from all our hearts.

From the not-so-deep south, comes a welcome letter from the one and only **Robert** (Bob) **Forbes,** of Knoxville, the land of much gold or so we hear. Golly, this is a gold mine for me this time around, as Bob writes a small hand, two whole pages. Bob, it seems, attended the 40th reunion of his class at Somerville High, in June, but did not show up for Alumni Day. Bob is truly one of the faithful, so his 40th must have come at a far different time from our event, or so I choose to think. He mentions having met **Warren Daniel**s at the 40th, who had not been seen by anyone in 10 years, or is that so, Warren? Warren is a civil engineer with the Geological Survey, and lives in Ammandale, Va. Now Warren, it is your move next, no? We need more new faces and handwritings in the file. Bob is still preparing reports on the TVA Division, Water Planning. I hasten to apologize to Bob for leaving out the word "Planning" last time! When? I just don't remember.

Bob writes, "We do a lot of planning towards encouraging industrial development in areas where the elevation is such as to encourage such industry, high enough to avoid the flood problems. We also are giving increased attention to air and water pollution, pesticide residues, fertilizer movement through runoff and rainfall." That seems to be it, and many, many thanks, Bob!

Now comes **Thomas K. Fitzpatrick,** formerly of Charlottesville, Va. Tommy, it seems, decided to end it all (at Charlottesville), and go back to practicing his profession, architecture. But let's begin where he did. "I should have written months ago, but. . . ." I know, Tom, you are forgiven as you too are really one of the faithful, and I do hear from you regularly. Tom has recently been traveling in England, Scotland and Ireland; a trip involving some pleasure but mostly business. The main news is that Tom is giving up his teaching, and going back into consultation, and "other things". Best to Beverly, and, we'll need you at the 40th, come 1973, not so far off as it appears. Many, many thanks, Tom. We all love ya.

May we remind y'all about the forthcoming 40th Reunion Gift to M.I.T. Many have not comprehended that the pledge may be paid over five fiscal years, one of which is gone. The Institute year starts July 1, and the second available year started last July, so that some of us are a bit behind in getting started. When Ellis and/or any of his committee get in touch with you, won't you save him or them a lot of headaches and hard work by being prepared with your pledge, which ought to be your considered highest figure. This is the last drive run on any formal basis. Don't forget that your gift is deductible.—**Warren J. Henderson,** now of 1079 Hillsboro Beach, Pompano Beach, Fla. 33062, but always Fort Rock Farm, Drawer H, Exeter, N.H. 03833

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One of the faithful who missed our reunion last June was **George Bull.** I wrote him, telling him that as penance he would have to give us an account of his travels. He came through in grand style with the following: "You were kind enough to express an interest in my trip to South America that caused me to miss the reunion. Actually, it was a rather conventional swing around the continent: Down the West Coast to Santiago, over to the Atlantic, and then north via Montevideo and Rio.

"The big cities and the route are well known to all, but I might describe two unusual features of the trip. The first was an excursion from the city of Bogota in Columbia to a place called Zipaqueria. There is a mountain there that is mostly rock salt. For many years they have been mining the salt and now there has been hollowed out a huge cavern which has been blessed by the local Catholic hierarchy and is called the 'salt cathedral.' It is quite dark as the salt is mixed with coal and the walls really look very much like granite. The church is supposed to be as large as Notre Dame de Paris, a statement with which I agree, having seen Notre Dame. The Pope visited it when he was in Columbia a few years ago.

"The other feature was the trip to Macchu Picchu. This is supposed to be the place where four Grand Incas reigned back in the Andes after Pizarro killed Atahualpa. It was known that the Incas had a stronghold somewhere in the mountains during that time, but its location was lost and never found again until Hiram Bingham located it in 1911. One flies from Lima (at about sea level) to Cuzco, which is 11,600 feet up, in about 50 minutes in a very modern little jet plane. They tell you to rest for a few hours, which I was very glad to do as my heart was going bang-bang. After a few hours in bed we were equal to lunch and an afternoon of driving around Cuzco to see the old Inca ruins in the area and their wonderful stone work which fitted huge but complex pieces into walls that have stood for centuries.

"In the early morning we took a narrow gauge railway through the mountains for about three hours. The line drops to about 8,000 feet to a small station at the foot of a mountain called Macchu Picchu that has given its name to the great ruin. At the little clearing we took a

microbus for a trip up a series of switchbacks for a rise of about 1000 feet. The ruin is very impressive, with a series of forty terraces on which they grew their food. The view is fabulous as there are 12 to 18,000 foot mountains in all directions.

"There are the usual places that they think were the living places for priests, nobles, sacred maidens and all that. It is hard to know much about the Incas for they did not leave written records or basreliefs like the Mayans of Yucatan.

"Probably the most significant site in the ruin is a place where three windows look down the valley. Hearsay histories written by early Spanish settlers have it that the Indians told them the Incas had gone to live in the place of the three windows. This was a very unusual statement as Andean huts do not have windows because of the intense cold. So there could not have been very many places with three windows.

"Mary Elizabeth and I have been fortunate enough to have seen all the great ruins of the world except Ankor Wat. Although others are more impressive in certain ways, there is none that can touch this one for location. I hope to make Alumni Day next spring and perhaps see you then."

Christmas seems long past but here are a few gleanings from Christmas cards: Winnie and **Ed Taylor** were in Tennerife, Canary Islands, boasting of bananas, tomatoes, and poinsettias (not from greenhouses.) . . . Margaret and **John Holden** had fled to Jamaica from whence they talk of 85° temperature, warm water and good rum. . . . From Selma and **John Streng:** "Glad you joined the club, (retired, that is). I did it two years ago—spend most of our time cruising in Florida or Bahamas on our 48 foot Wheeler."

Through the Alumni Association we got the following brief items: **Leo Carten:** "I was looking forward to the reunion to meet old friends again and get away from the turmoil of the Army Material Command Headquarters. But our son, age 18, came down with a high fever that kept him in bed for a week." . . . **John Hawkins:** "After reunion, spent a wonderful month in Peru, Chile, and Argentina, including six days on Easter Island." . . . **Jack Platt:** "I'm now manager and an associate of Brand-Moore Realty Corp., Hollywood, Fla. I work with the Educational Council and am vice president (Broward County) of the South Florida Club of M.I.T. Most importantly, I just became a grandfather (a baby boy to my son Michael, M.I.T. '63 and Harvard Business School '65 who is a product manager for General Foods, White Plains, N.Y.)

One of the items discussed during the Alumni Officers' Conference last fall was the success some classes had obtained by sending cards as we are notified of address changes by the Alumni Office. We decided to try it too, and the early results are very heartening. From the early responses we find that: **Edward S. Fleming** retired in 1961 with the rank of Captain U.S.N. He had spent five years in Puerto Rico, 24 in Massachusetts, and the last two in Washington, D.C. He is now with Interstate General Corp. as a project manager on commercial and office building projects in their Washington office. He and his wife Priscilla have two sons, James, 26 and Stephen, 27. . . . **Franklin C. Safford** is with the Development Treating Facilities of the Drever Co., Huntington Valley, Pa. He and his wife Madeline have one son, 16 years old. . . . **Stanley S. Knight** is still nearby, with the Continental Screw Co. of New Bedford, Mass. He denies any hobbies, but we wonder.— **Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631

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The newsiest bit this month came from **John H. Colby** of Islamorada, Fla.: "Worked all summer as consultant to Johnson Service Company and returned here November 1st for the winter. My oldest boy, drafted at age 25 after two years in the Peace Corps, is now in Seoul, Korea. My second boy, on graduating from Columbia, joined the Peace Corps and is now in Senegal, West Africa. The youngest is a freshman at Hofstra University.

"Saw quite a bit of **Jack Ballard** this summer. He is enjoying his retirement and thinking of moving to Oregon. Spent the evening with **Carson Brooks** last spring in Richmond; still with Reynolds Aluminum. Talked to **Al Greenlaw** on the phone this summer. He is now with Boeing in Seattle. **Larz Ekwurzel** has moved to Deerfield Beach, Fla. and we expect to get together shortly."

From **Walter H. Stockmayer:** "Am still on the Visiting Committee to the Chemistry Department at M.I.T. Just finished organizing and acting as local chairman for the fall meeting of the National Academy of Sciences held at Dartmouth, October 13-15. You may have read about the attendant 'Shockley Incident' in the papers. Am going to England next April for a Faraday Society discussion, but will be home in plenty of time for our 35th reunion. See you there!"

Harold M. Oshry is Director, Management Committee and Vice President for Operations, Braden Industries, Broken Arrow, Okla., and officer of several companies. He says he is still retired! . . . **P. A. Guarino:** "Now Associate Technical Director of Harry Diamond Laboratories (Army) .Three children married and on their own (seven grandchilden). Heart attack last year, but O.K. now. Betty and I planning to attend 35th reunion in June."

John D. Seaver recently became Vice President, Corporate Business Planning, Itek Corporation. . . . **Paul S. Mormino** of Westwood, Mass. has been appointed Assistant Vice President of Charles T. Main and is in charge of personnel administration. . . . It was recently announced that the Lee and William Abramowitz Chair in Polymer Chemistry has been established in perpetuity at the Weismann Institute of Science by **William L. Abramowitz.** . . . **Dexter J. Clough** represented the Institute in October at dedication ceremonies for New Husson College. . . . The Cambridge Chamber of Commerce has elected **Max Wasserman** to a three-year term as one of its directors. . . . **Allan Q. Mowatt,** Vice President and General Manager of Astrodyne announced the expansion of his company into Canada by appointment of Douglas Randall as exclusive Canadian representative. . . . **Brydon S. Greene,** in a nice note has told us about his efforts on behalf of the less privileged people of this world.

A sad note was received announcing the death on September 8, 1969 of **George A. Peterson** of Cranston, R.I.— Co-Secretaries: **Phoenix N. Dangel,** 329 Park St., West Roxbury, Mass. 02132; **Irving S. Banquer,** 20 Gordon Rd., Waban, Mass. 02168

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George Trimble has returned to his duties with the Martin Marietta Corp. as a vice president following a leave of absence during which he served as Deputy Director of NASA's Manned Spacecraft Center in Houston. His address is now Apt. 817 Hampton House, East Joppa Rd., Towson, Md. 21204 . . . Combustion Engineering has announced the appointment of **William Abbott** as director of pressurized water reactor engineering. Before joining the Connecticut firm in 1966 Bill was employed by Westinghouse. He makes his home in Simsbury . . . **Donald Kenny,** vice president and director of Rohm and Haas, has been elected to the board of directors of University City Science Center in Philadelphia . . . Also in the City of Brotherly Love **Bob Worden** has received a Certificate of Appreciation from the Institute for his services as Special Gifts Area Chairman for the 1969 Alumni Fund.

Edward Dashefsky has been elected a senior vice president of Raytheon Company. He will continue to serve as general manager of the Microwave and Power Tube Division with headquarters in Waltham. Ed and Rose live in Newton Centre and Ed is serving as a director of Newton Junior College. Their son, Barry, is at Tufts Medical School after graduating from Harvard . . . **Norman Copeland** has been promoted from assistant to chief engineer of the du Pont Company. Norm has been with du Pont since 1937. He received his doctorate in chemical engineering from the University of Delaware in 1949.

Notes accompanying their contributions to the Alumni Fund have been received,

with gratitude on all counts from: **Al Bagnulo** who continues in charge of the Alexandria (Va.) office of Pope, Evans, and Robbins. In addition to normal consulting activities the firm operates a laboratory for research and development on combustion systems and related air pollution control; **Gerry McMahon** reports no changes in job or activities except that the children continue to grow up and scatter. He is with Citgo in Lake Charles, La.; **Walter Seinsheimer** has switched from industrial engineering as such and is now spending full time as an arbitrator between labor and management.

I regret to report the death on November 26 of **Nicholas Lefthes.** He had been with the General Electric Company in Lynn as an electrical engineer for 29 years. On behalf of the Class I have expressed to his wife, Amelia, and his son and daughter, our sympathy at their loss.

It is almost unbelievable that our thirty fifth reunion is only fifteen months away. Do start your planning now so that June, 1971, will bring you to New England.—**Alice H. Kimball,** Secretary, P.O. Box 31, West Hartland, Conn. 06091

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W. Gardner Barker, President and Chief Executive, Thomas S. Lipton Inc., Englewood Cliffs, N.J. is a member of the sponsoring committee for the Underwood-Prescott Professorship at M.I.T. The Professorship will be the first endowed chair in the field of food science in the United States. . . . **Bill McCune, Jr.** has been named executive vice president of the Polaroid Corp., Cambridge, Mass. . . . **Sydney B. Karofsky** has recently been elected a member of the Advisory Board of the Commonwealth National Bank, Brookline, Mass. Sydney founded Northeastern Wallpaper Corp. and Northeastern Wallcovering, Inc. both of Boston and Hartford. He also founded Walls Unlimited, a Boston designer's showroom and is a past member of the Business Industrial Development Committee of the Port of Boston and of the Planning Board of the Town of Brookline. . . . **Joseph Morgan** has been promoted to director of research-coordinator at Texas Christian University. . . . **Walt Wojtcazk** represented the Institute at the Inauguration of the President of St. Joseph College.

Goodwin R. F. Gay, a former selectman of Northboro, Mass. initiated the idea of a study of Northboro, with the cooperation of the Urban Systems Laboratory of the Institute, to investigate both the problems faced by such communities on the fringes of urban expansion and alternate means for controlling growth in order to maximize desirable development. . . . **Arthur J. Levine** is a partner of the New York securities firm of Weis, Voisen, Cannon Inc. . . . **Richard H. Ewert** has been elected treasurer of the American Gear Manufacturers Association. . . . **Jack Simpson** is now Product Manager, Industrial Transmissions of the Warner Gear Division, Borg-Warner Corp.

Certificates of Appreciation have been awarded by the Institute to **Phil Peters, Art Zimmerman, Jerv Webb, George De Arment** and **Phil Dreissigacker** for outstanding effort on behalf of M.I.T. in the 1969 Alumni Fund.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; Assistant Secretary, Professor **Curtiss C. Powell,** Rm 5-325 M.I.T., Cambridge, Mass. 02139; Assistant Secretary, **Jerome Salny,** Egbert Hill, Morristown, N.J.

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One of the joys of the Christmas season are the Christmas cards and notes from fellow members of the Class of 1938. **Dave Acker** sent a rather complete history of the year, a portion of which follows: "Now that our son Glenn has had more than a year of exposure of college life and has participated in activities such as the Woodstock Festival and the November mobilization in Washington, we have great sympathy for the young people in the future that they face. Our hope is that we older ones haven't given up in our struggle to improve the world in which we live.

"Members of our immediate family are all well. We rejoice in being grandparents once again. A daughter, Candy Lee, was born to Karl and Jeanne on September 4. My wife, Marion, has been chairman of the music committee at church and I finish a term as deacon, this year as chairman. There were added responsibilities, for our minister resigned in January, so we had to arrange for an interim pastor, and then came participation on the pastoral committee. And together we completed a year as presidents of POMS, the volunteer group to support the school music program. Now we serve as treasurer, just to keep in touch.

"The year has entailed more than a fair quota of travel. For ADL there have been two trips to Algeria, one to Greece, another to Surinam, and a quick one at the start to London. But the three of us in Bedford also had a vacation week in California in February, and Marion, through Karl's arrangements, is planning another for December."

Harry Hollander writes as follows: "Teaching plastics as an art and craft form in universities in U.S. and Canada. Writing book on plastics for artists and craftsmen, publisher Watson-Guptill."

A postcard from Burt Grosselfinger contains a clipping showing that **Dave Torrans** was named technical superintendent of the Lake Charles, La., plant of Hercules, Inc.

Harold Strauss sent Don Severance a postcard from Spain: "Henrie and I are driving through Spain with another couple and are having a great time. We are spending a month in Europe. Sorry I couldn't get to Alumni Officers' Conference but just too many conflicts including this trip." . . . The *New York Times* reported the engagement of Mary-Jane Atwater, daughter of **Frank Atwater,** to Lieutenant (jg.) John Daniel Wilman. They plan to get married next summer.

The big item for your consideration this month is Homecoming weekend which will include the Boston Pops Orchestra at Symphony Hall on Sunday night, June 14. If you get your reservations in early, we can have a group of tables for the Class.—**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney & Co., 140 Broadway, New York, N.Y. 10005

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Hopefully, by the time you read this column, you will also have received a notice of our 30th reunion in June.

From **Agustin Cabrer,** "I am the grandfather of twins. Boy and girl—I sure got twice as much as I bargained for!" . . . **Dick Falls** writes that his third son, Arthur is a freshman in pre-med at the University of Prince Edward Island at Charlottetown, P.E.I., Canada.

Stewart Miller is the author and co-author of a series of three articles in the September, 1969, *Bell System Technical Journal*: "Integrated Optics: An Introduction," "Improved Relations Describing Directional Control in Electromagnetic Wave Guidance" and "Some Theory and Applications of Periodically Coupled Waves."

I. M. Pei is again in the news as the architect selected for the new IBM skyscraper to be erected in New York between 56th and 57th Streets on Madison Avenue. . . . **Norm Klivans** is vice president of the Electronics Systems and Instruments group of Gould, Inc., which was formed as a result of the merger of Gould-National Batteries, Inc. with Clevite Corp.

Dick Speas has been named to the Board of Trustees of the Academy of Aeronautics. He has long been interested in aeronautics and is a licensed commercial pilot. In 1951 he formed R. Dixon Speas Associates, Inc., a consulting service specializing in business aircraft, airline operations and airport planning.

Tom Creamer has been elevated to the position of executive vice president of the First National City Bank of New York. He heads the Commercial Banking Group. Tom joined City Bank in 1946, after two years as Assistant to the President at Tech and four years as an officer in the U.S. Navy. Tom was named assistant vice president in 1950, vice president in 1956 and senior vice president in 1966. Tom and his wife Phoebe have five children and live in Scarsdale, N.Y. Classmates who are looking for a loan

in the present tight money situation, should now know who to see. . . . **Russ Werby** is chairman of the Northeastern Section of the American Chemical Society. . . . On November 18, **Kenneth Davis,** vice president of Bechtel Corp. received the Robert E. Wilson award in Nuclear Chemical Engineering of the American Institute of Chemical Engineers. At the presentation of the award, he spoke on "Problems and Prospects for Nuclear Power." Kenneth joined Bechtel in 1958. Previous to that he was director of reactor development for the U.S. Atomic Energy Commission in Washington from 1954 to 1958, following four years as manager of the research division of the California Research & Development Company. At present, he is also an honorary director of the Atomic Industrial Forum after having been its president for two years.

The following members of our class received Certificates of Appreciation for outstanding work in the 1969 Alumni Fund Drive: **Frank Penn** (Fund Board Member 1967-1869) and **Jacob Samuelson** (Special Gifts Area Chairman for Seattle)

Brevity may be the soul of wit, but it usually makes for a dull column. More letters please!—**Alvin Guttag,** Secretary, Cushman, Darby & Cushman, 730-15th Street N.W., Washington, D.C. 20005

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Mitchell J. Marcus, Herbert R. Moody and **Frank S. Wyle** were among alumni awarded Certificates of Appreciation for their outstanding efforts on behalf of M.I.T. in the 1969 Alumni Fund.

Eugene E. Crawford has been elected president of the California Council A.I.A. which is the state and regional organization of the American Institute of Architects. Eugene's term of office is for the year 1970. In 1969 he was elected a Member of College of Fellows, American Institute of Architects. . . . **John P. Cutler** is currently associate and chairman of the design committee at Reid and Tarics Associates, Inc. of San Francisco, Calif.

Erling Hustvedt is currently an operations research analyst in the Technical Analysis Division of the National Bureau of Standards, Washington, D.C., working on such projects as a parcel sorting system for the Post Office, a study of the scope of the water pollution problem for the Coast Guard, and an operations research symposium for the National Bureau of Standards.

Joseph A. Bergantz is currently associate provost, Faculty of Engineering and Applied Sciences, State University of New York at Buffalo. He was formerly chairman of the Department of Chemical Engineering. Commencing in the fall of 1968, he spent a sabbatical half year as visiting professor in the Department of Chemical Engineering at University College, London, England.

1970 Alumni Fund	Class	Donors	Per Cent	Dollars
	1941	136	28	$13,955
	1942	136	26	8,455
as of	1943	131	25	13,277
	1944	156	21	10,309
	1945	87	26	24,475
January 27, 1970	1946	130	26	7,524
	1947	159	24	19,011
	1948	277	26	30,142
	1949	211	27	12,510
	1950	294	28	61,355

Harlan E. McClure is currently president of the National Architectural Accrediting Board and a member of the Interprofessional Task Force on Environmental Design.

Howard Morrison has been named product sales manager for Fairchild Controls, a division of Fairchild Camera and Instrument Corporation. He will be responsible for sales of the firm's precision potentiometer, potentiometric pressure transducer and pressure sensor product lines.

Howard was product sales director for Bourns, Inc. prior to joining Fairchild. Earlier he served as sales manager for Computer Instrument Corporation. He lives with his wife and three children in Smithtown, Long Island, New York.

Newell H. McCuen, formerly chief engineer-mechanical for General Motors Overseas Operation, has now been appointed to a new position of manager, Forward Planning-Product Analysis and Control. Newell joined General Motors in 1941 as an inspection supervisor with Cadillac Motor Car Division and transferred to Hydra-Matic Division as a project engineer in 1946. In 1952 he was transferred to Chevrolet Motor Division where he served successively as senior project, assistant staff and staff engineer. He joined GM Overseas as assistant chief engineer in 1960 and was named chief engineer in 1963. He is a member of the Society of Automotive Engineers, the M.I.T. Club of Detroit and president of the Bloomfield Country Day School Board of Trustees.—**Walter J. Kreske,** Secretary, 53 State Street, Boston, Mass. 02109; **Everett R. Ackerson,** Assistant Secretary, 831 Cranford Ave., Westfield, N.J.; **Michael Driscoll,** Assistant Secretary, 63 Center St., Nantucket, Mass.

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As promised in the December Class Notes, here's **Lou Rosenblum**'s account of his visit with Savita and **Nanu Amin**: "One way to convey the warmth of Nanu and Savita's hospitality is to describe some of the varied activities of our three day visit with them. Nanu and his brothers all left India for engineering, scientific or business education. Each one runs or works in the family manufacturing enterprises and most are active in Baroda civic affairs. The enterprises include the manufacture of electrical insulation materials, electric motors, pumps, machine castings, generators and a fruit and vegetable canning plant.

"The three new Jyoti manufacturing plants at Mogar house brand new, Indian-made machine tools, a very rational plant layout, a company cafeteria that charges 12¢ for a three-course hot meal, big bicycle-parking areas, and many pretty flowers and shrubs. The as yet unused major part of the 65 acres of this new site is farmed commercially. The profits from the crops (corn and tobacco) more than cover the cost of the perennial and annual planting around the buildings. There are some 45 separate manufacturers already in the Mogar area, and the town has a university with 8,000 students. In this environment, the young engineers of Jyoti are not reluctant to take production assignments away from the far bigger city of Baroda. Some parts of the Jyoti facilities in the middle of Baroda date back to the middle 1940's.

"Nanu started my tour on Saturday morning with the old pattern shop (wood forms for making pump castings primarily of steel but also some of nonferrous metals). In many of the buildings, and certainly in the foundry, the real old timers are still around who remember when Nanu was a trainee before he went off to the States for college. They also remember his insistence in 1943 that he would learn more and turn out better work if he did his own dirty work. All of Jyoti's workers are paid on an hourly basis, but they seemed to be working (and to be used to working even when the boss was not taking a visitor through the buildings) as if they were on individual incentive payments. There is a bonus plan that operates for the company as a whole.

"As we entered the extensive machine shop building, Nanu said that the old machine tools of German, Czech, U.S., U.K. and U.S.S.R. manufacture, will be

replaced in the next 18 months with brand new equipment, almost all of it of Indian manufacture. The relatively new Swiss jig borer (Society Genevoise) is already in a separate air-conditioned building. The rest of the machine shop will be supplied with cool air under positive pressure—primarily because of the dust in 'summer' (May and June 110° Fahrenheit dry heat) rather than the humidity of the monsoon season (July and August 95° damp from intermittent heavy showers).

"The several sheds for parking bicycles house about 1,000 Indian-made editions of the Raleigh. Roughly half of the employees pedal to work. The senior engineers and supervisors drive motor scooters, motorcycles, or small automobiles, unless their jobs entitle them to a company car, and in some cases a driver as well. Among the other fringe benefits for the technical staff are a liberal budget for travel to conferences in other cities, occasional engineering and/or sales trips to West Asia (the Middle East), or to Europe and free family medical care at the Company's clinic.

"Over the years a few of the key people have left Jyoti Limited to set up their own manufacturing operations. Nanu cited several instances where these men had become suppliers to Jyoti for components that were formerly purchased outside, or which are no longer economically feasible for Jyoti to manufacture internally. He says that he is now far more philosophical than he used to be about the occasional departure of a very able man, particularly if the able individual turns out to be a valued supplier.

"Every March (at the end of the school year), high school graduates apply by the hundreds for the two-year paid trainee course that is run by the Jyoti personnel department. My inquiry about dropouts was answered by detailing the parental promises required for each trainee, the partial deferred compensation while being trained, and the responsibility of the personnel department for maintaining good communication with these and all other employees. With a compound annual growth rate in sales and about 14 percent per year over a 10 year interval increasing productivity by improved methods, materials, and tools, average pay scales for the area, but better than average fringe benefits, Jyoti's labor trouble has been small, and its employee turnover even smaller.

"Nanu and Savita manage a four-acre fruit, vegetable, and flower garden in Baroda and their 115-acre experimental farm that is 40 miles away in the village of Vatadra, with a similar blend of thoroughness, humaneness, and obvious personal pleasure. The procedure upon arrival was a report from the manager, rapid-fire questioning by Nanu, cold drinks for all present, a tour of the animal stalls (eight pairs of bullocks and three horses), a look at the two tractors and other machinery, and then a leisurely walk to the far-end rice paddies, pump house, pond, and trees full of a dozen wild monkeys.

"Later that evening I learned, when I asked Nanu what kinds of agricultural records were kept, that the farm is subdivided into 30 fields. For each of these, there are notations with the date of plowing, planting, weeding, fertilizing, insecticide spraying, and harvesting. By comparing the techniques (bullock and steel plow versus tractor), the kinds of seeds, etc., Nanu, the manager, and any of the neighbors who may be interested, can readily see which agricultural procedures seem to work best for the soil, rainfall, and drainage in Vatadra. One of the Amins' major crops is mangoes. They recently built a canning factory called VaFa and brought in a food chemist to run it under Savita and Nubhai's supervision. VaFa hopes to export its mango, pear, peach, and tomato juice, as well as tomato paste."—**Ken Rosett,** Class Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

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Most of the time our notes concern progress of our classmates in the industrial world. However, this month I am pleased to furnish information on one who has been commended for performance in the military. U.S. Air Force Colonel **Paul H. Fisher,** Course XIV, of Ent A.F.B., Colo., has been decorated with the Bronze Star Medal for meritorious service while engaged in military operations against Viet Cong forces. Colonel Fisher, a weather staff officer, was cited for his performance while serving with Detachment 4, 1st Weather Group in Vietnam. He is now assigned to the 4th Weather Wing at Ent where he resides with his wife Betty and their three children, David, 16, Leonard, 8, and Paula, 4.

Also receiving an award was **Norman I. Sebell,** our Alumni Fund Class Agent and one of the three Reunion Gift Chairmen. He was given a Certificate of Appreciation for the fine record last year.

Warren I. Signell was presented with an award at the 77th Annual Banquet of the Society of Naval Architects last November. He won the Captain Joseph H. Linnard Prize as author of his outstanding professional paper, "Marine Boiler Design Today." Warren recently left the Foster Wheeler Co. after 21 years to join the J. J. Henry Co. in New York City as Chief Marine Engineer.

In a note from **John E. Yocom,** he reports that he is Director of Engineering and Technical Programs at the Travelers Research Corp. His group is involved in a wide variety of interesting research studies in air pollution control. John states that there are numerous other M.I.T. grads at T.R.C., mostly meteorologists and mathematicians. The Yocom family resides in Simsbury, Conn.
(continued on p. 136)

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Max Ruehrmund, Reunion Gift Chairman, advises that there will be another telethon on Tuesday, March 24. On December 1, Max, **Bill Blitzer, Al Bowen** and I managed to call 70 classmates during a two-hour span. The telethon later this month will again be conducted from my office and we hope to reach at least 200 of you. Yes, we are after you, your reunion attendance and your money!

Lou and **Pete Hickey** report that they are now trying to convince daughter Lisa that she should postpone her wedding date one week so her parents can attend their 25th Reunion! . . . The **Jerry Pattersons** shall not be so fortunate! Tony, their oldest, graduates from Coe our reunion weekend and will be married the following weekend in Erie, Pa.! Jerry continues, busy with much singing in the church choir plus nine performances of "La Traviata" later this month in Binghamton, N.Y. . . . We continue to be awed by the beauty of the West, as reflected in photos of the **Sherry Ing** and **Vince Butler** children displayed in their Christmas cards. Yes, and many thanks to other classmates not specifically mentioned for your Christmas notes.

Ellen and **Jim Brayton** were off to Europe this past Fall. . . . Rosemary and **Nick Mumford** have the good fortune of being able to combine son Nicky's graduation from the Institute and our reunion as one "big bash"! Rob Mumford is on a submarine tender in Guam while the Mumford girls, Ayliffe and Elizabeth, have a German exchange student as a sister this year.

Seven regional or area dinners were held Friday, January 30, as part of your 25th Reunion Committee's continuing effort to bring you back to Cambridge June 12-15. From all reports each gathering was a total success, if success per se is to be measured in interest, awareness and fellowship. Congratulations to Chairman **Tom McNamara** and his regional cohorts: **Al Bowen, Pete Hickey, Dick Martin, Andy Marocchi, Wes Cowan** and **Bob McKenna.**

Through the efforts of the Institute and American Tel & Tel all groups—except for the forgotten (?) Philadelphia contingent—enjoyed a multiway phone conversation with one another. Yes, a so-called conference call with speaker phones in some instances and many household extensions in others. Not much continuity of thought but many many voices out of the past.

As for groups let's pick on the forgotten group first! The Philadelphia and Southern New Jersey area met at the Cherry Hill Inn, Haddonfield, N.J., with **Pete Hickey** acting as host. In attendance, Nina and **Bud Wilson,** Barb and **Bob Irvin,** Trudy and **Max Ruehrmund,** Lou and **Pete Hickey, Sam Haines, Dunc Luce, Bob Buxton** and **S. Gordon Smith, Jr.**

Reunion Book Chairman, Bob Maglathlin with Reunion Chairman, Tom McNamara (upper left), and former President, Dave Trageser, with Class Treasurer, Bill Meade (lower right), were among those who gathered at the M.I.T. Faculty Club last January 30 for their regional dinner to boost the 25th reunion. Those gathering in other parts of the country included Al Bowen and Tom Hewson (upper right) at the Chris Bolands in Greenwich, Conn., and Wes and Pat Cowan with Bud and Norma Hetrick (lower left) in Ballwin, Mo. All expect to attend the reunion in June.

At headquarters, i.e., the M.I.T. Faculty Club in Cambridge, the following moved in from out of the woodwork: Dee and **Frank Gallagher, John Cullinan,** Jan and **Dave Flood,** Marion and **Howard Grant, Charlie Hart,** Anne and **Bob Maglathlin, Bill Meade,** Mary and **Gerry Quinnan,** Mary and **Dave Trageser, Ed Washburn,** Ginny and **Roger Hood,** Marge and **Dick Battin,** Ruth and **Dan Vershbow** and, lastly, Chairman **Tom McNamara** and wife Louise.

In Pittsburgh there were three voices of the past: **Tom Stephenson, Jumper Gammon** and **Andy Marocchi** together with wives having a gay affair at the University Club. In Rockville, Md., **Dick Martin** brought together **Bob** (Chubb) **Turner** and **Lee Schindel** again with wives.

Jean and **Chris Boland** opened their hearts and home in Greenwich, Conn., for Billie and **Al Bowen,** Betsy and **Tom Hewson,** Ruth and **George Landon,** Eva and **Pete Agoston,** as well as yours truly.

The **Cowans**—West and Pat—and the **Hetricks**—Bud and Norma—had a most pleasant evening at the Cowans in Ballwin, Mo. Our Los Angeles group consisted of **Bob McKenna, Lloyd Balsam** and **Ray McDowell.** As this phone conversation was with Cambridge only your scribe does not know where the girls were! I just talked with Chairman Tom who reminded me that San Francisco's **Vince Butler** was to chair a meeting February 5, as part of a major M.I.T. regional Alumni evening with the M.I.T. Logarhythms, while Chicago's **Tom Markey,** North Jersey's **Ed Stoltz** and the North Country's **Chuck Buik** plan gatherings in mid March. Yes, names and associations of 1942-1945 which can, and will, become renewed friendships of today as we reunion in Cambridge this June.

To date—and you must recognize that these notes are being written in early February—we only have a list of "hopefuls" which we trust shall convert to a list of "actuals" as spring grows towards summer. Hopefuls not listed above include Wil and **Curt Beck,** Val and **Ed Reed,** Kate and **Jake Freiberger,** Barbara and **George Upton,** and Suna and **Art Hall**—all from Texas, Elaine and **Spence Standish,** Fairlie and **Slim Pasfield,** Jeanne and **Bill Martin,** Mary and **Charles Hooker,** Jayne and **Bill Humphreys,** Edna and **J. J. Strnad, Julian Busby,** Elaine and **Bill Shuman, Warren Miller,** Debbie and **Alvin Cohen,** Virginia and **Bob Hildebrand, Sam Moore,** Renie and **Dwight Collmus,** Mary and **Jim Hoaglund,** Ellen and **Jim Brayton, Bob Black,** Jan and **George McKewen,** Janice and **Fred Test,** Louise and **John Morrison,** Betty and **Don Strang,** Betty and **Guy Gilleland,** Margot and **Walt Borden,** Eleanor and **Joe Neschleba,** Roxie and **Emmett Day,** Marley and **R. Tully Bradford,** Barbara and **Red Howell,** Myrna and **Bob Roth,** Jean and **Don Kahn,** Rosemary and **Nick Mumford,** Elaine and **Ray Pelley,** Lulu and **Oakie O'Connell, Steve Eppner,** Jeb and **Al Werner, Larry Van Ingen,** Judy and **Bill Blitzer,** Janet and **Charlie Patterson, A. Franklin Hahn, Jr., Les McCracken, Joe Reese, Dick Winkler, Paul Swartz,** Betty and **Bill Nicholson, Don Stevens,** and **Luigi Russo.** What an array!

—**C. H. Springer,** Secretary, MFB Mutual Insurance Co., 420 Lexington Ave., New York, N.Y. 10017

(continued from p. 134)
John B. Breymann, 3rd, joined the Portfolio Department of the Old Colony Trust Co., the trust arm of the First National Bank of Boston. Those of you who have glum faces after the 1969 stock market drop may want to get some good tips from John.

Several personal notes have been received. **Wallace P. Dunlap** has a wife who is a good correspondent. She reports that their daughter Louisa, 17, has been accepted at Wellesley where she is hoping to major in math and take some courses at M.I.T. Their oldest son, Sandy, graduated from Dartmouth in '68 and is now in Vietnam while their married daughter, Ann, has resumed her studies at the Kansas University Fine Arts Department, while her husband is in Vietnam. Their youngest, Arthur, is a 9th grader. . . . **Robert Ilfeld** writes that he has given up his house in Jackson and moved to 795 Watersedge, Ann Arbor, Mich. 48105. He has a townhouse there but commutes 40 miles back to Jackson.

The *Review* Office has received the following note from your Class Secretary: "I'm sorry but I can't get out the Class of 1944 notes this month [for April]. I'm flat on my back in the hospital with a slipped disc. However, by next month I'll either be well or be able to get a substitute. Best wishes."—**John G. Barmby,** Secretary, IITRI, 1825 K St. NW, Washington, D.C. 20006

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It is often difficult for us to believe that the years have actually passed so quickly and that the time of our 25th reunion is less than fifteen months away. I do hope that many more classmates will plan to attend this 25th reunion than have attended previous reunions.

A major event of the 25th reunion is the 25-year gift by our class to M.I.T. The class officers and members of the gift coordinating group have already begun to work to achieve our goal. Our goal is a gift of $400,000 which would include all gifts made in the period from 1966 to 1971. The closing date of the class gift would be June 30, 1971. As of the end of 1969 we had a total contribution of about $100,000. The 25-year gift coordinating group has divided the country into 10 areas, each with its chairman.

The goal for each area is dependent upon the number of class members in that area. The New England area has the largest goal as it contains 23.3% of the alumni. This area is headed by Messrs. Lappin, Westcott, Spoerl and Edgerly. The New York City area is headed by Ted Henning, and upstate New York by Alan Gruber. The area chairmen for eastern Pa. and Washington, D.C. are yet to be decided. The southeast area is headed by Don Burke, the east midwest by George Ley and the west midwest by Bill Schield. Glen Dorflinger will head the southwest, and the far west is to be championed by Bill Cahill. You will soon be contacted by one of these gentlemen or their co-workers so please be responsive and courteous to them for their generous expenditure of time for the Institute they love and support.

Morry Chomitz has written us from his home in Wyncote, Pa. Morry has been project manager of Day and Zimmerman, engineers and contractors, for the past five years. He has designed and built some very interesting and complex chemical plant facilities during that time. I should like you to share a part of his recent letter to me, "Dear Russ: My lack of response to your request for news was not due to apathy, but rather to my strained circumstances. After fighting a heroic battle for four and a half years, Nancy, my wife, died of cancer in October. Our children, Ken, 16, Martha, 13, and Jon, 10, have borne up well, I think mainly because they shared their mother's last days. Nancy was bedridden for six months and we cared for her at home to the end."

Daniel D. Streeter, Jr., received his Ph.D. in biomechanics at the Catholic University of America in June, 1969. Dan's thesis was a stress analysis of the left ventricular wall of the dog heart. The work was performed at the National Heart Institute. Dan is now a Research Fellow of the Washington State Heart Association at the University of Washington Medical School. In this connection the state of Washington Heart Association has awarded $277,000 for research. Dr. Streeter's assignment in this research project will be to investigate the distribution of stress through the heart wall. As Dan would like to hear from his old friends, we are pleased to provide his new address: Dr. Daniel D. Streeter, Jr., 4201 51st Ave. N.E., Seattle, Wash. 98105.

R. K. Joslin recently retired from the Navy after 32 years of service. Mr. Joslin has begun a new career with the Advanced Systems Program office of the Submarine Signal Division of Raytheon.

C. B. Sibley has returned to Needham, Mass. to continue with the Norton Co. in its Vacuum Equipment Division. For the previous three and a half years Cliff was assigned to Europe helping to set up a manufacturing group near Geneva, Switzerland.

Another retiree from the Navy is **Eric C. Newberg, Jr.** Eric joined the Boeing Co. in Seattle and had various assignments in the missile, space and commercial airplane divisions, and was part of the Boeing-Apollo team at Washington, D.C.

Roy E. Bockhorst has been promoted to vice president of the Brass Division of Olin Corp. Gene joined Olin in 1948 as a Brass Division trainee and has advanced through the organization to his present position. Gene's headquarters will continue to be East Alton, Ill. and his home in Godfrey, Ill. Both cities are very near St. Louis, Mo.

Arthur Y. Taylor has retired as president of Jackson and Moreland Division of United Engineers and Constructors and is now a principal of Chas. T. Main, Inc., Boston, Mass. Arthur has recently been elevated to the grade of Fellow by the I.E.E.E. for his leadership in the planning and management of nuclear power.

One last but important class note is a request of **Donald E. Burke,** who is heading the 25-year gift coordinating group for the southeast area. Don would like any members living in Florida to write or call him at 1818 Ceasar Way So., St. Petersburg, Fla. 33712, telephone 813-867-1576, to help coordinate the 25-year class gift. Please send us a note on your activities and interests.—**Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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The Holiday season of joy is now officially over—the postman just brought the income tax forms. We have beautiful snowy weather but as yet I have not been on skis since family company have kept us very busy. Son Bob and I have been playing some hockey so I have at least a fair complement of aches and bruises.

The mail this month starts with the distaff side of the class. First, as promised earlier, a nice letter from **Virginia Carter Grammer,** "Glad to serve as an example, however humorous. Charles' brothers and sisters would thank you, I am sure, if they knew about your interest. In fact, he now has a new brother, which does make it plural. To begin at the beginning, which was a long time ago, first is Beth, 22. She was graduated last spring from the R.I. School of Design with a B.F.A. in Illustration and is working as an artist at Hallmark Cards in Kansas City, Mo. On November 29 she was married to Lieutenant Philip Marshall, USAF, also R.I.S.D. (architecture) but currently working as an industrial engineer at Grissom AFB, Ind. Rennie, 20 is living in Concord, Mass., and working (we assume) in the Boston area. Margaret, 17, is a senior in high school. She spent the summer in Rio de Janeiro and is anxious to get back there.

"The school in which I teach is an independent school, not in the city school system. I am still working for the degree I began at M.I.T. and have one astronomy course to go, which I expect to take this spring. I have a little boning up to do, since part of it is based on plasma physics and magnetohydrodynamics, which they had not spelled out in 1944-45 when I last took physics. So I shall end up in the class of '70, University of Rochester, having begun with the Class of '47 at Tech. I don't know if that makes me feel young or old. Don't let the astronomy fool you; my field is really applied math, computer programming.

"Rey, my husband, also listed as Class of '47 because his VI-A course was completed then, has really been doing much more interesting things than I. He has been with Eastman Kodak since 1947, working on a variety of projects, mostly secret. He was in charge of the design on the camera for the five Lunar Orbiters which took pictures used in determining the landing sites. He is active in Boy Scouts, and is on the church board. (I was until last year.) He was on the school board for seven long years, president of it for several, but has been off now for a few.

"We had an English exchange student with us last year, which we enjoyed very much. So we have another daughter, Linda Buckley, currently at college in Coventry, England. And if we include Linda's and Philip's brothers and sisters I have some children who are almost as old as I. Good show, what? Hope to see you at the reunion—if it doesn't interfere with my graduation."

Virginia we trust you'll make it at Rochester in '70 so will see you in Cambridge in '72. While mentioning reunions I have a note from Al Bruneau of the Alumni Day committee pointing out that June 14 and 15 are the Homecoming days this year. M.I.T. has Symphony Hall for the Pops on the 14th and tickets will be allocated basically on a first come first served basis.

Ginny Ferguson Hildebrand sent a newsy Christmas poem giving the activities of the family. Ginny is keeping busy with Camp Fire, P.T.A. and swim team and is apparently doing some tutoring in chemistry. Bob is now manager of spacecraft at Boeing and older son Bruce is a sophomore in electrical engineering at Tech. Dave is a junior in high school, an end on the football team and spent the summer working for the Seattle Pilots baseball team. Daughter Susan, in addition to working on her judo and dancing, took training with her Irish setter. I hope she did better in the latter course than our kids have done with our collies. I don't know whether it is the dogs or the children but we have had some dropouts.

A United Savings bulletin has quite a writeup on the Norwood family. Mrs. **Virginia Tower Norwood** met Lawrence when he was teaching at school and they were married upon her graduation. They moved on to Yale while he worked on his doctorate and she taught math at a junior college. Their next stop was Fort Monmouth, N.J. where they joined the Signal Corps and spent five years working with radar and communications. From there it was to Los Angeles and Hughes Aircraft where they have been for the last fifteen years. Both are now senior engineers and participated in the Apollo program. Their children are, Naomi 15, Peter, 9, and David, 4, so Virginia combines the jobs of engineer and mother.

Bill Brett writes that he has just formed a management consulting partnership, Brett & Kerr in New York to specialize in the management of urban programs. Bill has spent the last 18 months operating the Mayors Management staff in New York. . . . **Bob Drye** is chairman elect of the N.I.M.H. Psychiatry Training Review Committee. . . . **Charles Hunt,** our intercollegiate dinghy champion, has been named manager of the racing sails division of the Morgan Yacht Corp. in St. Petersburg so he is staying in the sailing field.

A clipping in the *Boston Globe* advises that **Jack Rizika** has taken over as chief executive officer of Handley Page Aircraft in England. Apparently Jack's Northern Research and Engineering Corp. took over this financially ailing British aircraft company and he is trying to untangle it. The article infers that Jack is now residing in England so our class gift letters may come for a while from overseas. . . . I note in the *Wall Street Journal* that **Jim Phillips** is now a director of Vance, Sanders & Co. . . . Several clipping services have sent notice that **Ken Block** was elected president of A. T. Kearney & Co., management consultants. I'm embarrassed to say that I lost my class notes file but I think this was covered a couple of months ago. . . . **Barrett Brown** has joined Aerosol Techniques in Milford, Conn. as assistant to the president. He had previously been with Mobil Chemical. . . . Bob tells me it is now time to play in the neighborhood hockey game, so will sign off until next month.—**Dick O'Donnell,** Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

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I find myself immersed in winter snow and cold, but already confronted with thoughts of spring since you will read these lines in March. Hence this announcement: At the M.I.T. Homecoming on the evening of June 14, M.I.T. is taking over the Pops at Symphony Hall. If enough classmates act promptly we may be able to get tables on the main floor. Anyone interested should reply promptly to me or Stan Margolin.

Robert C. Lincoln reports, "Be envious: took off the years 1967-68 to travel in Europe and do some private study. And, believe it, though the odds were against it, at age 42 I got married! And thereby 'acquired' four children! And shortly thereafter became a 'grandfather'!! Am now a manufacturing consultant for Keene Corporation at the Reston Development Center. It's not New England but it's very pleasant living." It sounds great, Bob; it was good to hear from you.

From news releases we learn that **Dwight Hibbard** is vice president of information and personnel for the Cincinnati & Suburban Bell Telephone Co., having previously served as chief engineer and general plant manager. He has been named to the board of trustees of the Blue Cross of Southwest Ohio. . . . **Charles L. Storrs** (Ph.D. in physics) has been appointed director of advanced reactor development in the nuclear power department of Combustion Engineering's utility division. . . . **Fred I. Brown, Jr.** has been elected president of Associated Industries of Arkansas. He is president of the Arkansas Foundry Company in Little Rock and is active in civil affairs. . . . I find only one '49er on the list of awards of Certificates of Appreciation in behalf of the 1969 alumni fund: **James W. Christopher,** for work in Andover, Mass. Congratulations, Jim—what happened to all the rest of us? Best wishes to all.—**Frank T. Hulswit,** Secretary, 77 Temple Road, Concord, Mass. 01742

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Allen E. Light reports that, for the past 13 years, he has been employed by AVCO-Lycoming—Williamsport Division in Pennsylvania. His present position is Chief Engineer. AVCO-Lycoming produces piston engines that power more than 50 per cent of all the light aircraft built today. Their engines power aircraft manufactured by Piper, Beech, Cessna, Aero Commander, along with numerous other airframe companies, both domestic and foreign. Allen and his wife, Edna, are the parents of two boys—Wendell, 17; Stacey, 12; and one girl, Charlotte, 10.

Charles R. Faulders is presently Manager of the Flight Sciences Branch of the Engineering Division, Space Division, North American Rockwell, in Downey, Calif., keeping busy with Apollo, Saturn Stage II, and new business activities.

Donald W. Ramsey is employed by General Motors Corp., Rochester Products Div. He is responsible for analysis and evaluation of engineering lab tests on carburetors and other automotive components. He has been married for 5 years. He and his wife, Suzanne, have a daughter, Laura Lynn, four; and a son, Robert Bruce, two and a half. He is presently involved as co-chairman of a joint committee studying goals for churches of downtown Rochester.

In June of 1968 **James A. Drobile** became Managing Partner of Schnader, Harrison, Segal & Lewis, a law firm in Philadelphia. . . . **Richard T. Keller,** an educational councilor for M.I.T., is a Senior Research Chemist in Waste Treatment Research at the Dow Chemical Co. His oldest daughter is a student at Michigan Tech. . . . **James A. Daley** recently joined the Hartford National Bank & Trust Co., in Hartford, Conn. He is now Senior Vice President in charge of Bank Operations. . . . **John H. Litchfield** has been elected President-elect of the Society for Industrial Microbiology. He will take office as President in August 1971. . . . From Toronto we learn that **Beryl Borsook** is now president of Dorothea Knitting Mills, Ltd., a knitwear manufacturer.

Jack Keverian has been named General Manager of Kennecott Refining Corp., Anne Arundel County, Maryland, subsid-

1970 Alumni Fund	Class	Donors	Per Cent	Dollars
	1951	245	26	$10,301
	1952	203	25	57,066
as of	1953	157	23	4,520
	1954	155	24	4,346
	1955	143	23	4,024
January 27, 1970	1956	194	26	5,158
	1957	182	25	5,581
	1958	183	24	5,275
	1959	185	24	4,618
	1960	189	25	4,951

iary of Kennecott Copper Corp. Since May 1966, Mr. Keverian has been associated with Chase Brass and Copper Co., Cleveland, Ohio, also a Kennecott subsidiary. Previously he was manager of the Applied Research and Development Laboratory, Foundry Dept., for General Electric Co. in Schenectady, New York. In 1960, he received the Investment Casting Institute Distinguished Service Award; he earned the Prize Paper Award from the AIME Electric Furnace Conferences in 1962 and 1964. Since 1964, he has been listed in *Who's Who* for the East and Mid-West.

Stanley Martin, Jr., is currently Manager, Advanced Requirements, at Bell Helicopter, Fort Worth, Texas. Past involvements of his have included the XV-3 tilt-rotor convertiplane and the Italian version of the Bell 10-place helicopter, the first Italian helicopter to be certified by the F.A.A. . . . **Robert L. Titus** has been named General Products Manager of Arrow-Hart, Inc. Mr. Titus was formerly Product Manager of Murray Manufacturing Corp., now a division of Arrow-Hart. He is responsible for the development of all new products, the modification of existing products and for developing new applications of products to meet short and long range marketing requirements. . . . **Gerard A. Hirschfield** has left System Development Corp. after 11 years and is now with Lebell Consulting Scientists and Engineers in Encino, Calif., working on some very interesting computer industry planning problems.

Frederick R. Bentel has his own firm of Bentel & Bentel, Architects. His partner and wife, Maria A. Bentel, '51, was recently awarded two major commissions: a 3,000 seat auditorium and related facilities building for C. W. Post campus of Long Island University and the Hempstead Bank Office Building at Mitchel Field. The Bentels have 3 children. —**John T. McKenna, Jr.,** 2 Francis Kelly Rd., Bedford, Mass. 01730

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John B. Aycrigg has been the Associate Hospital Director at the Fort Logan Mental Health Center in Denver, Colo. since May, 1968. . . . **Marvin Burns** is Managing the Space Systems Group at the I.I.T. Research Institute in Chicago. He is applying space technology in the biomedical area by working in the artificial heart program and in the development of circulatory assist devices. He met **Earl Kletsky** (who at last check was helping to direct Syracuse University's Sensory Communications Lab) at an A.S.M.E. conference on Engineering in Medicine and Biology. He also hears from **Ed Bronstien** on Ed's frequent trips to Chicago from St. Paul. . . . **Russell C. Casella** is a theoretical physicist at the National Bureau of Standards. He, his wife Marilyn and their two children, Sheryl and Cynthia live in Potomac, Md. . . .In March the Norton Company promoted **Robert E. Donovan** to a Senior Research Engineer in the metal bond laboratory. Before coming to Norton, he was a senior metallurgist at the Nortronics Division of the Northrop Corp.

Merton C. Flemings authored a feature article titled "Casting Metals" in *Science and Technology*. In April, the Executive Committee of the M.I.T. Corporation announced that Mert was promoted to Professor. We're not sure if the two events were related, but congratulations Mert! . . . Professor **Thomas Erber** edited an M.I.T. Press book *Francis Bitter: Selected Papers and Commentaries* which honored Professor Bitter. Professor Erber teaches physics at I.I.T. . . . **Ernest Holzmann,** S.M. VI, completed his Ph.D. requirements in electrical engineering at Stanford last June. (John Morganthaler please note! See article further on). His thesis was "On Dendritic Growth." He is working in the Information Sciences Laboratory at the General Electric R and D Center in Schenectady, N.Y. His note said that his wife, Martha, and their six children would join him in June. I trust that they made the journey safely. . . . **Breene M. Kerr** was elected to the M.I.T. Corporation. He had been Vice President of the Alumni Association during the past year and has been a member of the Corporation Development Committee since 1965. He is a senior partner of the Resource Analysis and Management Group Inc. . . . **Hannes B. Kristinsson** is a general partner in ICETEX Company which provides a subscription investment advisory service. In less than one year, he has doubled his own capital and the goal of ICETEX's partners is to become financially independent within five years. Care to join them?

James F. Logan is President of Logan-McPeak, Inc. general contractors in Pulaski, Va. The firm engages in commercial and industrial building construction. Jim and Nancy had two sons at last count. . . . After noting that **Robert L. Mac Callum, Jr.** continues to reside in Pittsburgh, Pa. as the Eastern Region Manager for the Mining and Metals Division of Union Carbide, we have received a note that he was promoted to Director of Market Development of this division and has been transferred to New York City. The family (Jim about 6½, Heather about 4½ and wife Sharon about ?) are living in Weston, Conn.

John H. Morgenthaler who has purported to be the last living Ph.D. candidate in our class (see earlier story) has now been at Bell Aerosystems since January of 1967 as the Director, Advanced Technology Research. He is one of the newer fathers though—he and Kay added a second son (3rd child) in April, 1968. . . . A newspaper article told us that **William C. Plouffe** has been named to head the Merrimack Valley Industrial Center. The Center functions under the Massachusetts Department of Commerce and the Lowell Tech Research Foundation and is designed to acquaint industry, labor and business in the Merrimack Valley area with information dealing with scientific and technological advancement, marketing knowledge and new techniques in industrial and public relations.

Walter A. Rutes, an associate partner of Skidmore, Owings and Merrill, is serving as chairman of the advisory board of the Hult Research Fellowships for the construction industry in New York City. . . . Professor **George R. St. Pierre, Jr.** was elected chairman of the Faculty Advisory Committee to the president and Board of Trustees at Ohio State University. . . . Eugenie and **Herbert S. Sawyer** are living in Ellicott City, Md. He is working for the Department of Defense at Fort George G. Meade, Md. . . . **Norman C. Telles** has been appointed Deputy Chief of the Radiation Bio-Effects Program of the National Center for Radiological Health in Rockville, Md. After graduating from M.I.T., Norman received a medical degree from Boston University and a M.S. in radiation biology from the University of Rochester. He has been a commissioned officer in the Public Health Service since 1956.

Charles Kojabashian is a principal in the consulting firm of Foster-Miller Associates in Waltham, Mass. His primary functions center around planning and directing engineering programs. The Kojabashians live in Sudbury, Mass.— **Howard L. Levingston,** Secretary, 358 Emerson Rd., Lexington, Mass. 02173; **Walter Davis,** Assistant Secretary, 346 Forest Ave., Brockton, Mass. 02402; **Paul**

Smith, Assistant Secretary, 11 Old Farm Rd., North Caldwell, N.J. 07006; **Marshall Alper,** Assistant Secretary, 1130 Coronet Ave., Pasadena, Calif. 91107

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All of you must have received information by now on our reunion in June through **Gene Davis** and his committee. Combining the reunion on Saturday and Sunday with the "Pops" on Sunday night and M.I.T. Homecoming on Monday makes for a superb holiday that we hope you will all try to attend. To hear Gene describe Blackpoint Inn (near Portland, Maine), it sounds just perfect, and conjures up visions of a delightful weekend to blow off some steam and enjoy ourselves. A number of people have been active with telephone calls and chain letters to get their own groups together to attend en masse. How about you?

Mobility seems to be in: **Tony Diglio** is back in the States in Corpus Christi, Texas, having completed his stint in the Netherlands. **Jim Bartsch** has moved to Nantucket?? . . . **John Rossettos** left AVCO to become an Associate Professor of Mechanical Engineering at Northeastern this past September; he reports the latest addition to their family, Linda, the previous September. . . . **Cora** and **Olaf Stackelberg** and Peter, Paul and John are spending the academic year away from Duke University at the University of Illinois where Olaf is a Visiting Associate Professor in the Department of Mathematics.

Edie and **Bob Greene** and their three girls have *really* been on the move! In September Bob accepted a position with the Ford Foundation in Indonesia for two to four years and during the following months, the Greenes got equipped, Berlitzed, immunized, etc., etc. at a great pace before leaving Sherborn for their new home in Jakarta—with stops at Disneyland, Hawaii, and Singapore en route. They plan to visit the U.S. once a year, but meantime welcome correspondence c/o The Ford Foundation, P.O. Box 2030, Jakarta, Indonesia (no zip code necessary. . .) .

Closer to home **Philip Marshall** of Marshall R&D, Burlington, Mass., has been serving as a National Director of the Institute of Environmental Sciences, he being a member of the Boston Area Chapter. . . . **Charles Mohr,** coauthor of a paper on internal waves in the ocean in the *Journal of Ocean Technology,* is now with Arthur D. Little, Inc. . . . Sorry, but that's it.—Secretaries: **Mrs. J. H. Venarde** (Dell Lanier), 16 South Trail, Wilmington, Del. 19803; **L. Dennis Shapiro,** Aerospace Research, Inc., 130 Lincoln St., Boston, Mass. 02135

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Last December I met **John Collins** on a flight from Louisville to New York and we talked about his recent move from Tonawanda to Tarrytown, N.Y. John's new job title is Manager, Process Engineering, Molecular Sieves Department, Materials Systems Division of Union Carbide. Next day I stopped by Arlington-Symmes Hospital to visit **Lloyd Beckett** who was recuperating from a gall bladder operation. Not a very merry Christmas for Lloyd. . . . **Tom Boberg** is a research supervisor at Esso Production Research in Houston. . . . **John Broyles** continues as a Senior Research Officer at the London Business School where he teaches mathematics to postgraduate students and does research on stock price behavior.

Dick Bush was married to Elizabeth Hart of Milwaukee, Wis. in April 1969. They live in Laurel, Md. and Dick is a supervisor at W. R. Grace's central research labs in Clarksville. . . . Last September **Bob Carlson** became Dean of the new Babcock Graduate School of Business at Wake Forest University. . . . **Fred Hoeltzel** has been named district sales manager of the wire drawing machinery department of Morgan Construction Company, Worcester. . . . **Bob Kaiser** presented a paper on synthesis of ferrofluids at the Magnetics and Materials Conference last November in Philadelphia.

Paul Luckett was recently promoted to Assistant Vice President and General Sales Manager of El Paso Products Company. . . . Rev. **George Luthringer** has been awarded a graduate teaching assistantship at the University of Cincinnati Department of Speech and Theater Arts. . . . From my most faithful Christmas correspondent **Bob Mansperger** comes word that he is in charge of Research Engineering for applied research on machine tools, textile machinery and other products for Warner and Swasey. . . . **Earle Ryba** co-authored a bibliography on thermal expansion in intermetallic compounds for the A.E.C. last June.—Co-secretaries **Bruce B. Bredehoft,** 3 Knollwood Dr., Dover, Mass. 02030; **T. Guy Spencer, Jr.,** 73 Church St., Weston, Mass. 02193

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Many tidbits this month. . . . A recent news release advises that **Steve Weisskoff** has been appointed manager of the Long Range Planning and New Products Development Department of Enjay Chemical Company's Synthetic Rubber Division. The department is responsible for research coordination, new business planning and long range planning, as well as new product development. Prior to his new position, Steve was the Division's Economics Analysis Coordinator. He joined Enjay in 1957 as a technical sales representative, and has held various sales positions, including Advertising and Sales Promotion Coordinator for the Division. Steve, who holds an M.B.A. from Butler University, lives with his wife and two children in Westport, Conn. The photo reproduced here accompanied the news release.

Ira Zames is now president of Unilux,

F. E. Hoeltzel, '56

S. Weisskoff, '57

Inc., an electronics firm in New York City. He and his wife are parents of a boy about nine months old. . . . In September, **Edward Friedman** was promoted to Associate Professor of Physics at the Stevens Institute of Technology. . . . **Henri Fenech** left M.I.T. after spending four years as a graduate student and eight years on the faculty of the Nuclear Engineering Department. He is now responsible for setting up a Nuclear Engineering Department at the University of California's Santa Barbara campus.

James Beck writes, "I have been at Michigan State University, Department of Mechanical Engineering, the past seven years, the last two as associate professor. My research has been in the area of inverse and estimation problems in heat transfer." . . . **Tom Roberts** has left the University of Michigan to form Thomas S. Roberts Associates, a management development and consulting firm. He has also acquired control of Masterco Press, Inc., a publisher of business economics and finance and management books. . . . **Jim Cunningham** writes that he is still working with **Charlie Koch** and his brothers Dave and Bill, '62, in starting and helping small technical companies. He adds, "I just moved into a home in Brookline and am 'enjoying' all the 'pleasures' of home ownership."

Bob Tuffias advises that he married Judith Koslow of Boston in 1961 and has two daughters. Bob received his Ph.D. from Stanford's Department of Aeronautics and Astronautics in 1967 and is employed in the Autonetics Division of North American Rockwell as member of the technical staff, Inertial Instruments Department. . . . **Gerald Sapers** and his wife are the proud parents of a daughter, their second child. They are building a new home in Warrington, Pa., and expected to move in November. . . . **Jules Byron** joined Williams Real Estate Co. Inc. in New York City as a vice president specializing in office leasing.

As I finish this column my family and I are traversing the Baltic on the *Finlandia* after a wonderful holiday in Holland. Susan and **Arthur Aznavorian** spent Christmas Day with us. We hoped to see **Jim Chorak** who, as I previously wrote, is now living in Brussels. But time went so fast that we only got together by telephone. Jim reports that he and his family are enjoying Brussels very much. They will probably be there, he said, for five or ten years. That's all for now.—**Frederick L.**

Morefield, Secretary, Tiirasaarentie 17, Lauttasaari, Helsinki, Finland

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"The what? The 15th reunion? You're putting me on." Not really—**Gary Fallick** has been named as our next reunion Chairman and has already started preliminary planning for the big event. Gary served on the 10th reunion committee so we'll have an "old hand" guiding the activity.

Eugene Elander is chairman and Associate Professor of the Department of Business at Atlantic Community College in Mays Landing, N.J. . . . **Donald Zalkin** received his M.S. degree in electrical engineering last June at the Polytechnic Institute of Brooklyn. . . . **Anthony Salotto** has joined the faculty of Pace College in New York City as an Assistant Professor of Chemistry. . . . **Ira Schwartz** is currently serving as secretary of the New York Chapter of the Society of Photo-Optical Instrumentation Engineers. . . . **Edward Crowell** has been elected a member of the American Federation for Clinical Research. . . . **Les Sodickson** is working at American Science and Engineering in Cambridge on major projects such as clinical laboratory automation and remote sensing from rockets and satellites. Les writes: ". . . to our son, Daniel, now age three, Isabel and I have added a set of twins, now seven months old, Deborah and Aaron."

As most of you know, or soon will know, **Jeff Ingram** has been named associate director of the M.I.T. Alumni Fund where he will be concerned with special programs such as reunion gifts and with the development of graduate departmental organization. Prior to this appointment, Jeff served as the Southwest Representative for the Sierra Club where he was intensively engaged in activities related to conserving our environment. . . . **Stan Klein,** regional editor of *Machine Design,* wrote an interesting article in the September 18 issue regarding the trends in engineering education at M.I.T. Titled "Technology's Privileged Offspring", the article also discusses the first job experiences of this new breed of engineer. Although **Tom Blood** has been living in Montreal for the past seven years, he writes, "I am still a U.S. citizen. I am now a partner in the architectural firm of Gorman/Mixon/Blood which was started in April 1969 and now has offices in Montreal and Atlanta, Ga. Barbara and I have two sons, Stephen and Christopher. This year I am serving as a visiting professor at McGill University's School of Architecture and also as treasurer of the M.I.T. Alumni Association of Quebec." . . . **John Ten Eyck** reports that he now has his own architectural firm and is also serving as chairman of the El Paso County, Colo., Planning Commission. In addition, he is a director of the Rocky Mountain Alumni Club.—**Michael E. Brose,** Secretary, 199 Sudbury Rd., Concord, Mass. 01742; **Antonia D. Schuman,** 22400 Napa St., Canoga Park, Calif. 91304

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I spent a pleasant evening with Cynthia and **Myer Kutz,** listening to the interesting details of their fall European jaunt. On this trip they concentrated on the Scandinavian countries which they enjoyed very much. Myer, after several years in Cambridge working at the Instrumentation Laboratory and at American Science and Engineering, spent last year doing post-graduate work at Columbia University before accepting a position with Cox Engineering in New York City. Myer joins the growing list of 59ers who are putting their literary talents to good use with the publication of his book *Temperature Control* by John Wiley & Sons. Look for it at your neighborhood book stall! . . . Other Course II classmates heard from this month include: **Ron Rosenberg** who writes "with my wife, four children, dog and gerbil, I made the trek west this summer to Michigan. At Michigan State University, I have taken up residence as the Mechanical Engineering Department's systems analyst and computernik. We invite all our former enemies to visit us, especially during winter." . . . **Emil Battat** informs me that there was a new addition to the family, Norman, last June. He goes on to say, "as a result of my diversification activities, I was appointed vice president of a new company, The Kaiser Trading Company, which was formed as a wholly owned subsidiary of Kaiser Aluminum and Chemical Co."

A recent press release announced the appointment of **John McElroy** to the position of Executive Vice President and Treasurer of Computing Efficiency, Inc., a Deer Park, N.Y. firm engaged in the development and marketing of computer software programs which also provides computer system facilities management services. John was a Baker Scholar at the HBS and had served as Deputy Director of Manufacturing Planning and Control for the Grumman Aircraft Engineering Corp. prior to his recent appointment.

Dennis Lytle writes, "the Lytle family has returned to the Dear old USA after 2½ years in Rome where I based my travels for consulting assignments in Europe. My current position is Director of Consulting Operations for the Atlantic Region, Science Management Corp." He adds "P.S. Is there really a '59 class secretary??" Yes, Virginia, there is!

An interesting note from **Phil Beach** relates that Alisia Sterling Beach was born on September 17 and was out sailing with Susan and Phil at age three weeks! . . . **Dave Garelik** returned to the Boston area this past fall to become Associate Professor of Physics at Northeastern University. . . . Apologies to **Bill Long** for confusing him with classmate **Bud Long!** —Sorry 'bout that Bill! . . . **Dave Weisberg** writes that he has recently moved to Foster City, Calif. where he is now Director of Product Development for U.R.S. Data Systems. . . . **John Peterson,** presently Professor of Architecture at the University of Cincinnati informs me that he was an artist in "Laser Light—A New Visual Art" at the Cincinnati Art Museum, and that he has received a research award from the Bettman Fund for the study of critical judgment in architectural students.

One final item just under the wire: I received an announcement of the birth of a daughter to Carmen and **Carl Neu** during the last week of 1969. Congratulations are in order to the happy couple both for the new arrival and for Carl's impeccable sense of timing. . . . Well that's about all the news for this month. Keep those cards and letters coming or else I'll have to miss an issue and you all know how embarrassing that can be. —**Arthur J. Collias,** Secretary, Technical Forum Associates, Inc., 545 Technology Square, Cambridge, Mass. 02139

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On October 31, 1969 **Herman M. Schneider** was appointed an M.I.T. Assistant Professor in Electrical Engineering for two years beginning July 1 (on leave of absence for first year of appointment). . . . A faculty committee has been formed at the Massachusetts Institute of Technology to encourage research and teaching related to the nation's growing environmental problems. Formation of the new faculty group, known as the Committee on Environmental Problems, was announced October 23, 1969, and will plan the development of M.I.T. teaching and research in areas related to environment, recommend new policies and procedures needed to aid M.I.T. groups interested in dealing with environmental problems, and provide information and advice on funding related to environmental research support. **Jeffrey I. Steinfeld,** Assistant Professor of Chemistry is among the members of this new committee. . . . SCM MELABS, a subsidiary of the SCM Corporation, has recently announced extensive new line of MIL-spec filters and circulators. **Donald M. Dible,** the engineering manager under whom these products were developed, has recently been transferred to the position of National Sales Manager, Government Products Group-Components at SCM Melabs. It will now be his job to market these devices.

The response to the class president's letter is still coming in as follows: **Robert E. Fields** writes "I am currently Project Coordinator for Ethyl S.A. in Brussels, a sub of Ethyl Corporation, U.S.A." . . . **Raymond B. Landis** is currently teaching engineering at San Fernando Valley State College and working towards a Ph.D. at U.C.L.A. Ray lives in Granada Hills, Calif. with his wife, Dorothy, and their three children, Susan (8), Nancy (6), and Gary (3). . . . **Roger Rowe** graduated from the Harvard Business School last June and is presently working for Astro Communication Laboratory, a division of Aiken Industries, as acting contracts administrator. The Rowes are living in Gaithersburg, Md.

Robert Knighten writes that he and his wife, Carol (Ph.D. '67), are now assistant professors in mathematics at the University of Illinois at Chicago Circle. Their first daughter, Rachel, was born August 5, 1969. Carol is currently having her first pottery exhibit. . . . **Gordon R. Knight** brings us up to date with news that Jeffrey John was born March 22, 1969, and Gordon received his Ph.D. from Stanford University in September, 1967. Gordon is presently working in optical data processing as a member of the Research Staff at Ampex Corp. . . . **Mike J. Riezenman** reports, "I'm still single and enjoying the good life in New York. Professionally, I've switched from engineering to publishing; my current position is Microwave Editor of *Electronic Design.*"

1970 Alumni Fund as of January 27, 1970

Class	Donors	Per Cent	Dollars
1961	143	20	$3,500
1962	150	21	2,857
1963	141	18	2,294
1964	169	22	3,026
1965	192	26	4,363
1966	192	26	3,602
1967	226	27	2,665
1968	206	25	2,976
1969	117	18	1,408

Jose A. Rionda, Jr., has just returned from a 15 month assignment with Esso Engineering Services, Ltd. in London, England. . . . **John Rothschild** received his M.B.A. from Columbia University and is currently advertising-marketing executive with Young and Rubicam Advertising, N.Y.C. . . . A short note from **Gerald L. Gottlieb** notes that he has completed requirements for a Ph.D. in physiology at the University of Illinois Medical Center and currently holds an N.I.M.H. Postdoctoral Fellowship there. . . . **Alan Kotok** writes that since graduation he has been at Digital Equipment Corp. in Maynard, Mass., and has since received his S.M. from M.I.T. As primary system designer of the PDP-10, he is continuing on the development of new pieces of the PDP-10 system. . . . **William M. Taylor** writes that he is now manager of Spacecraft Systems Dept. in the I.B.M. Real Time Complex supporting the N.A.S.A. manned spaceflight effort.

This interesting note comes from **Don D. Divinia:** "Managed to get married in spite of all my traveling; married a girl from Idaho in Tokyo that I met on Midway! Now back in Texas with a son. I am a technical supervisor in the Special Projects offices at L.T.V. Electrosystems, Greenville, Texas. Radio call is W5LNL . . . Q.S.O." . . . **Alan E. Fuchs** is now Assistant Professor of Philosophy at College of William & Mary. . . . **George C. Pedersen,** married with four children ranging in age from two to six years, joined Albany Felt Company after leaving M.I.T. in February, 1967. He is working in wet filtration and mist elimination as senior development engineer and as project engineer on government contracts.

George R. Gilfoil, Jr., writes "I have started a marketing services company whose aim is to become the marketing arm of those firms which require professional marketing services for domestic and international markets. My firm employs computer technology, where necessary, to solve marketing problems. The firm can be remunerated in cash or equity but based only on 'results'." . . . **J. Ed Anderson** writes he is now working in Urban Transportation under a grant from D.O.T. and H.U.D. Ed is also teaching an Honor Seminar on Technology, Man and the Future. . . . A note from **Lloyd Armstrong, Jr.,** who married the former Judith Glantz in July, 1965, states "I got a Ph.D. in physics from U. C. Berkeley in September 1965. Stayed at Berkeley as a Post-doctorate until December 1966. Then went to Westinghouse Research Center in Pittsburgh, where (I) stayed until Oct. 1968. Since then have been at Johns Hopkins University in Baltimore, where I am an Assistant Professor in Physics Department. Judy, who got Ph.D. in psychology from Berkeley in 1967, is currently Instructor of Clinical Psychology at the University of Maryland medical school.—**Gerald L. Katell,** Secretary, 310 Hoge Building, Seattle, Wash. 98104

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These notes are being prepared during the first week of January; a number of you with whom I have spoken expressed surprise at the lead time for Class Notes. . . . Several members of the class contacted me in attempt to gain admittance to the over-crowded How to Start Your Own Business seminar held last October. Unfortunately there was nothing that could be done at that point. However, there are other seminars on the same topic now planned for New York, Washington, Chicago, and San Francisco in the spring. I am now involved in planning seminars for the future. If you have ideas for topics I would appreciate hearing from you.

Harold Solomon writes that he completed his Course XIX Ph.D. last summer and was seeking work on the West Coast when he wrote. . . . **Mark Grebler** writes that he married the former Jill Axelrud and is now in business planning at W. R. Grace & Co. in New York City. . . . **Stephen Fisher** received a Ph.D. in mathematics from the University of Wisconsin in 1967 and was an instructor at the Institute from 1967 to 1969 and is now an Assistant Professor in the Math Department at Northwestern University. He married the former Naomi Grossman in June, 1965. . . . **Theodore Kaleel** is with the inertial instrument division of the Endevco Corp. . . . **John Lamberti** is a surgical resident at Peter Bent Brigham Hospital and living in Brookline. He reports a daughter Andrea.

Edward Dudewicz is an Assistant Professor of Statistics at the University of Rochester. . . . **John Mc Donald** is planning to continue as an Assistant Professor at Yale for at least three years. He writes that he would like to encourage Tech Graduates to consider the Yale Graduate school or the Yale Faculty. . . . **Robert Fortenbaugh** has changed jobs and is now with the Naval Air Development Center, Johnsville, Pa. He and his wife Barbara became parents for the first time in August 1969—a son Peter Robert. . . . **Roy Komack** received his M.B.A. from Boston University in May, 1969 and is working for the Plaxial Division of United-Carr in Newton, Mass. and living with his wife Connie in Brighton.

Mal Beaverstock reports that he is finally settling down in Connecticut and is working in computer control for UniRoyal. He is building a home in Woodbury and has a new son Jeff. . . . **Eric Zorawowicz** is with Lockheed—California in Rye Canyon, Calif. after receiving an M.S. from Penn State in 1967. He is married to the former Andrea Zygmunt of Windber, Pa.

Steve Colburn reports a son Eric born in May, 1969. Steve is teaching at M.I.T. —**Martin Schrage,** Secretary, 305 Massachusetts Ave., Arlington, Mass. 02174

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The Class Hero of the month is **Norman Wagoner,** who wrote to say that, after degrees in both humanities and architecture, he is organizing his own corporation to pursue the field of low-cost urban housing. Norman is enjoying his bachelorhood in Silver Spring, Md. . . . I received an announcement from Marlene and **Steve Schlosser** proclaiming the birth of George Young on November 12, 1969. The child appears bright, because the very next month he was already signing his name to Season's Greetings cards (along with his parents)! I also received cards from **Edward Casper, Robert Scott,** and **Robert St. Aubin.**

David Freeman is on the staff at the University of Pennsylvania. He was married in the fall of 1968, and is to have a paper published soon by the *Physics Review*. . . . **Michael Godfrey** is a Ford Postdoctoral Fellow at M.I.T. and also an Assistant Professor in the Civil Engineering Department. His son Ben was born December 21, 1968. . . . **Herbert Heller** is the Planning Director of Ulster County, N.Y. . . . **Ernest Henrichon, Jr.** is working in the area of pattern recognition for Information Research Associates in Burlington, Mass. He received both his M.S.E.E. and his Ph.D. from Purdue, and married his wife Margie in May, 1969.

Joel Kalman is working for Codex Corporation in Watertown, a young company doing R and D in digital communication systems. Joel is Brighton regional chairman for the M.I.T. Alumni Fund.

Larry Langdon is teaching math at Virginia Union University, where his wife also teaches. . . . **Roger Lewis** is on the faculty at the University of Maryland in the School of Architecture. He is opening an architecture and planning office in Washington, D.C. with classmate **Charles Chavarria.** . . . **Forest Meiere** (Ph.D.'64) has been appointed Chairman of the Physics Department at the Indianapolis campus of Purdue. . . . **Don Mided** is working as a business analyst for C.B.S. in their office for Latin American Operations in Mexico City. He has worked in such areas as royalty payments, acquisitions, quality control, and manufacturing maintenance. . . . **Peter Ordeshook** is a visiting Assistant Professor of Political Science at the University of Rochester. He married the former Miss Betty J. Johns in June, 1969. Betty is a nurse at Rochester's medical center.

Stephen Portnoy is an Assistant Professor of Statistics at Harvard, after receiving his Ph.D. from Stanford. . . . **Don Shapero** was married in December, 1968 to Diana Berner, a graduate student in psychology at Northeastern. . . . **Eugene Speer** received a Ph.D. from Princeton last June. **Warren Wiscombe** is now working for Systems, Science & Software in La Jolla, Calif. . . . That's the news for now. Let me hear from you.—**Ron Gilman,** Secretary, 5209 Peg Lane, Memphis, Tenn. 38117

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An urgent reminder—Have you made hotel arrangements, set up meeting places with other classmates and/or made dinner reservations (for Locke-Ober's, House of Roy, or possibly the F&T diner) for Reunion Weekend, June 13? Finalize your plans now!

Holiday notes included the following news: **Bill Samuels** is in New York City and is working on his father's campaign for New York State Governor. . . . **Roddy McLeod** is becoming involved in Virginia politics and is also consulting in local poverty programs. . . . **Matt Mleziva** is a data processing officer at Wright Patterson AFB; his wife, Brenda, has been doing volunteer work at a camp for handicapped children as well as taking care of their two-year-old, Seth.

Dick Ayers is now the Production Manager at the Bates File Manufacturing Company in Newington, Conn. . . . **George Hadley** attended the recent young alumni small business seminar and is spending most of his leisure time kayaking in the white water around Seattle. . . . **Mary Coffey** is an associate scientist in the geophysics section of Avco's Appiled Technology Division in Boston. . . . **Dave Disher** presented a paper, "Statistical Automatic Statics Analysis," at the annual meeting of the Society of Exploration Geophysicists in Calgary, Canada. . . . **Allen Pogeler** is in his first year at Harvard Business School. . . . **Priscilla Marrs Newberger** and husband, Stuart, are now living in Corvallis, Oregon. Stuart is now an associate professor at Oregon State. . . . **Bill Pike** is doing investment research for the Boston Company.

Martin Goldsmith completed his internship at Mt. Auburn Hospital and will begin residency in radiology in July. . . . **Sudler Hood** received his M.D. last June from Columbia and is now interning at Presbyterian Hospital, New York City. . . . **Ron Mandle** married the former Miss Linda Saltman, a Wheaton graduate, last November. The Mandles are now living in New York City. . . . **Joe Dyro** married the former Miss Elizabeth Wood of Pittsburgh in 1968 and is currently working on a Ph.D. in biomedical electronics at the University of Pennsylvania where he is also the chairman of the graduate school council.

Kathy and **Tom Maugh** report the birth of a baby boy, Tom 3d, last September. Tom should receive his Ph.D. in chemistry from the University of California next September. . . . The **George McQuilkens** recently added a son, Angus George. George works for I.B.M. in Boston and also writes book reviews for the *Boston Herald*. . . . **Jon Hanson** who reports the birth of a son, Dennis, last fall, is a chemical engineer in the production department at Hooker Chemical in Tacoma. He is now on the M.I.T. Educational Council and is also serving on the Environment Planning Commission for Washington Businesses.—**Jim Wolf,** Secretary, Brigham Rd., Gates Mills, Ohio 44040

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Upon awakening this morning, we found Oxford covered with a beautiful white blanket of frost. With such a quiet unusual morning like this, one wonders what justifiable activity he can pursue sitting with his cup of coffee in front of the roaring fireplace since the holiday season precludes any form of real work. The sudden discovery that today is the due date for this copy settled the matter straightaway.

Each month the mailbag shows a greater shift from the academic world to the working world. First, let's cover those still grinding away at the degree. **Leonard Russo** received an M.S. in physics from the University of Pennsylvania in August and is now in the computer sciences doctoral program there. . . . **John Siegel** hopes to get his Ph.D. in solid state sciences from Princeton this month (January) and looks forward to a teaching career. He has contacts with a few classmates who are also radio hams. . . . **Paul Liao,** presently studying physics at Columbia, married Karen Ann Pravetz on August 31, 1968. . . . **Paul Gustavson, Jr.,** who took Elisabeth Bustard to wife two and a half years ago, is in his fourth year of medical school, anxiously awaiting internship next year. . . . **Tom Grover** is a Ph.D. candidate in electrical engineering at Berkeley. . . . **Roger Rasmussen** married Linda Upson of Boston University in December, 1968, and is pursuing a Ph.D. in behavioral science at U.C.L.A., hoping to finish in '71.

Bud Buttrill leads off the list of those who have recently made the transition from student to money maker. Bud received his Ph.D. from Stanford in December, 1969, and is now an Assistant Professor of Chemistry at the University of Minnesota. . . . **Mark Schwartz** received an M.S. in organic chemistry and is working for Smith, Kline and French Laboratories in Philadelphia as a medicinal chemist. . . . **Richard Gray** is a research engineer for U.S.M. Corporation in Beverly, Mass., having received his M.S. in mechanical engineering from Penn State in June, 1969. In his spare time he races sailboats in Marblehead and already has one cup to his credit.

Hans Juvkam-Wold left M.I.T. with his Sc.D. in June and is a research engineer at Gulf Research and Development Co. He and his wife Connie were joined by a daughter, Greta Franceska, on July 15. . . . After graduation from Stanford Law School with a J.D. in June, **Rick Art** and his wife Gwen moved to New York City where Rick is working as an associate in the law firm of Chadbourne, Parke, Whiteside & Wolff. . . . **Sarosh Sukhia** adds to the news given by last month's mystery reporter: he completed an S.M. in chemical engineering at M.I.T. in February, 1968, and lives with his wife Nancy and son Rohi in Mamaroneck, N.Y. . . . **Bill Speaker** has been transferred to Australia for a year and a half. He reports good hunting for chamois and thar in New Zealand and lots of sun in Fiji. . . . **Carl Jockusch,** who got a Ph.D. with our class, is an Assistant Professor of Mathematics at the University of Illinois. He and Elizabeth have a son William and a daughter Beth. . . . In September **Bob Wells** joined Engineering Computer International, Inc., a small consulting firm in Cambridge formed by M.I.T. civil engineering grads. His daughter Jennifer has reached the two-year mark. . . . **Richard Levine** continues in the H.E.W. Office of the Secretary's Management Intern Program and will soon join the Center for Community Planning, the urban affairs coordinating body of H.E.W. . . . **Ken Kaiser** was appointed a staff member of

Lincoln Labs in August, 1969, after three years with Raytheon. . . . **Don Schwanz** works for Univac's Federal Systems Division as program manager of N.A.S.A., Air Force, and marine programs.

The Heroes of the Month are **Terry May** and **Fritz Schaefer,** who gain their distinction for being the first two classmates to address a letter to my Oxford address. After leaving M.I.T., Terry worked for a California construction equipment firm in San Francisco and Los Angeles until Uncle Sam asked him to join the fighting forces in May, 1968. A year later, he completed Artillery O.C.S. and was commissioned a Second Lieutenant, four days later marrying Melanie Kempton who had just graduated from U.C.L.A. Although Terry is now stationed at Fort Sill, Okla., he expects orders for Viet Nam soon. Fritz got his Ph.D. from Stanford last June, and since then has been an Assistant Professor of Chemistry at Berkeley. His research is in the theory of atomic and molecular structure. His wife Karen is teaching the fourth grade in nearby Moraga. He adds the following: "Since we're not sympathetic to the leftist activity in Berkeley, we rented a house in Orinda, over the hill from Berkeley."

That's it for this mailbag. Join Terry and Fritz. Be the first in your block to send me a letter at Oxford. Cheerio!—**Terry J. Vander Werff,** 24 Horwood Close, Oxford, England OX3-7RF

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I'm happy to note that my lucky number in the recent lottery was 364. And how did you do? Here's hoping that not too many of you will be receiving "Greetings" from Uncle Sam. We'll start this month with the military news, and the rest of the news will be mixed.

Andrew Tanabe is in the Air Force at SAC Headquarters in Omaha. After graduation he worked one year with I.B.M. at M.I.T. On June 4, 1969, he married Katharine Ann Weller, Simmons College, Class of '69, physical therapy major. . . . **Carleton Bryant** left the Navy at the end of October and began work as a shop superintendent at Bath Iron Works. . . . **John Podolsky** is a grad student in computer science at U.C.L.A., having completed his military service, including a year in Vietnam. . . . **Tom Grabenstetter,** back from a three-year tour in Germany, will be discharged from the USAF in March. . . . **Charles Spann** writes that he has 461 days to go. . . . **John Ritsko,** having finished two years of graduate work in physics at Princeton, was ordered to report for induction while he was in the middle of his Ph.D. thesis. He has accepted a direct commission as a second lieutenant in the Corps of Engineers.

Joseph Levangie is living in Boston, having graduated from Harvard Business School in March, 1969. He is working at Avco Systems Division as a business consultant and teaching marketing at Northeastern University. He writes, "Thank God, I'm still a bachelor!" . . . **Lawrence Burgess,** still single, received his M.S. in electrical engineering and the Engineer's Degree in September. He is presently helping design and build miniature radar systems at Aerospace Research, a very small company. . . . **Hisayuki Handa** obtained his M.S. from M.I.T. in February, 1969, and is working for Northern Research and Engineering in Cambridge as engineer in an aerodynamics group.

Andrew Egendorf is the first student to graduate from Harvard's new joint JD/MBA program. He has also started a new company, "Intercept," to aid graduate students in obtaining jobs in teaching. . . . **Charles Marantz** writes, "I completed the requirements for the M.S. degree in Aero and Astro at Stanford in August. Further education will be deferred until some later date, perhaps forever." . . . **Clayton Mac Donald** is back in school and hopes to make it through this time. . . . **George Nybakken** and wife, the former Christine Witmore, have a son Kristopher. George is working on a Ph.D. in engineering mechanics at the University of Michigan. . . . **Roger Arndt,** while teaching aerodynamics as Assistant Professor in Aerospace Engineering at Penn State, developed a new course in experimental methods. He also serves as Faculty Advisor to both the Penn State Model Airplane Club, a group he helped organize, and the student chapter of A.I.A.A.

James McGill is a planning research engineer at Battelle Memorial Institute, Columbus, Ohio. . . . Last June, **Richard Mistler** was promoted to research leader at Western Electric's Engineering Research Center, Princeton, N.J. . . . **Bill Dix** has been appointed Executive Secretary of the Educational Council at M.I.T. For the past two years Bill has been in the Peace Corps in the Philippines, where he taught physics to secondary school students. . . . Our Class Agent **Chuck Kolb** will be among 90 alumni to receive Certificates of Appreciation for efforts on behalf of M.I.T. in the 1969 Alumni Fund. . . . **Myron Sussman,** having received his Master's from Carnegie-Mellon University, recently was appointed to the faculty of Robert Morris College as a mathematics instructor. He is also a Ph.D. candidate at Carnegie-Mellon. . . .**Lenard Weinstein** recently married the former Naomi Aaronberg of New York City. They spent some time in Cambridge a few months ago. Lenard is working for his doctorate in math at Berkeley, and Naomi is in the Ph.D. program in molecular biology. He adds a P.S., "Resist the Draft!"

Gordon De Witte has just been transferred to the Nuclear Instrumentation Division of EG & G and is working in Salem, Mass., as an applications engineer. In October he underwent knee surgery for the third time to correct torn cartilage and other problems. Gordon became officially engaged in June to Dorothy Graham, a graduate of Mass. General. They plan to be married on May 10, 1970. . . . **Bruce Ressler** is working for N.A.S.A. Electronics Research Center in Cambridge. He will finish his M.S. at Washington University next year. . . . **Warren Belfer** is currently a grad student at the University of Illinois, Champaign.—**Jim Swanson,** Services Provinciaux, Beni-Mellal, Morocco

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Greetings from high above the murky Charles River in scenic Cambridge. We have a lot of news this month since it has been about seven weeks since the last column was due. (This gives the class secretaries a break during the holiday season.) The new M.I.T. President's Report says that people who received S.M. degrees last June were offered an average of $1K/month—so what are we doing staying in grad school? I've heard one or two comments about the awful alliterations which I've been using for section headings so I'm using some new ones this month. Furthermore, I encourage all of you to send in suggestions for better headings. If requested, contributions will be kept anonymous. So let's get on with the. . .

Nuptial Notes

We have news of two coeds this month although only one is in our class. **Brenda Zimmerman** has married David Ferriero. They are living in Beverly, Mass. . . . **Dan Gruber** plans to wed Elaine Leemon '70 next summer. Dan was discharged from the Army last March because of hardship and has been working for Merck & Co. in Rahway, N.J. doing computer-aided simulation of manufacturing processes. . . . Finally, **Robert Benveniste** writes that he married the former Toni Pace, Boston University '68, on October 12.

Military Miscellania

We'd like to apologize for inadvertently promoting **Bob Mitchell** to Second Lieutenant in the December issue. Bob is an A1C stationed at Lowry AFB, Colo. and writes that he is enjoying the skiing out there. . . . **Gary Bjorklund** was drafted on July 22, but his wife **Carolyn (Henry)** describes him as "the luckiest guy (in the Army)." Gary had been studying physics at Stanford and received his M.S., so after basic training the Army stationed him at Letterman Hospital in the Presidio of San Francisco, doing biophysics research on blisters, skin diseases, etc. . . . We've received notes from four other draftees in our class describing their latest assignments. In general they weren't as lucky as Gary. **Dennis Noson** is still at Fort Lewis, Washington doing the Army's dirty work—shipping graduates of infantry training to Vietnam. Dennis writes "Soon we'll be out of a job, we hope (we pray). Then we, the clerks, may be on our way to Vietnam, or Germany." . . . **Larry Rosenberger,** who was drafted in March 1969, is an instructor in the Pershing missile system at Fort Sill, Okla. . . . **Pete Rode** is stationed at Fairbanks, Alaska. . . . And **Carl Martland** is a stockade guard at Fort Devens, Mass.

Gary Johnson has graduated from AFOTS and was commissioned a second lieutenant. Gary is now stationed at Griffis AFB, N.Y. as an electrical engineer with the Ground Electronics Engineering Installation Agency of the Air Force Logistics Command. . . . **Ken Theriault** graduated from Navy OCS in August and is in school at Glynco NAS, Ga. Ken writes "Though the navy *has* me, they're having quite a time making up their minds what to do with me. Right now I'm on my second set of orders and about the third or fourth modification. It seems I'm going to the U.S.S. *Harry E. Yarnell* (DLG-17), a guided missile frigate out of Norfolk—but don't count on it." Ken adds that he has been in school for eight hours a day about nine months straight and that it's beginning to drag. . . . **Jay Sinnett** was promoted to Lieutenant (j.g.) on June 6 and is now stationed in the Washington, D.C. area with the Naval Electronics Systems Command. . . . Lieutenant **Gordon Logan** is in pilot training with the Air Force and writes "love it and recommend it to anyone who has 20-20—just beats the hell out of engineering!" . . . Second Lieutenant **Stephens Richards** has been awarded Air Force pilot wings at Randolph AFB, Texas. Steve is an AFROTC graduate.

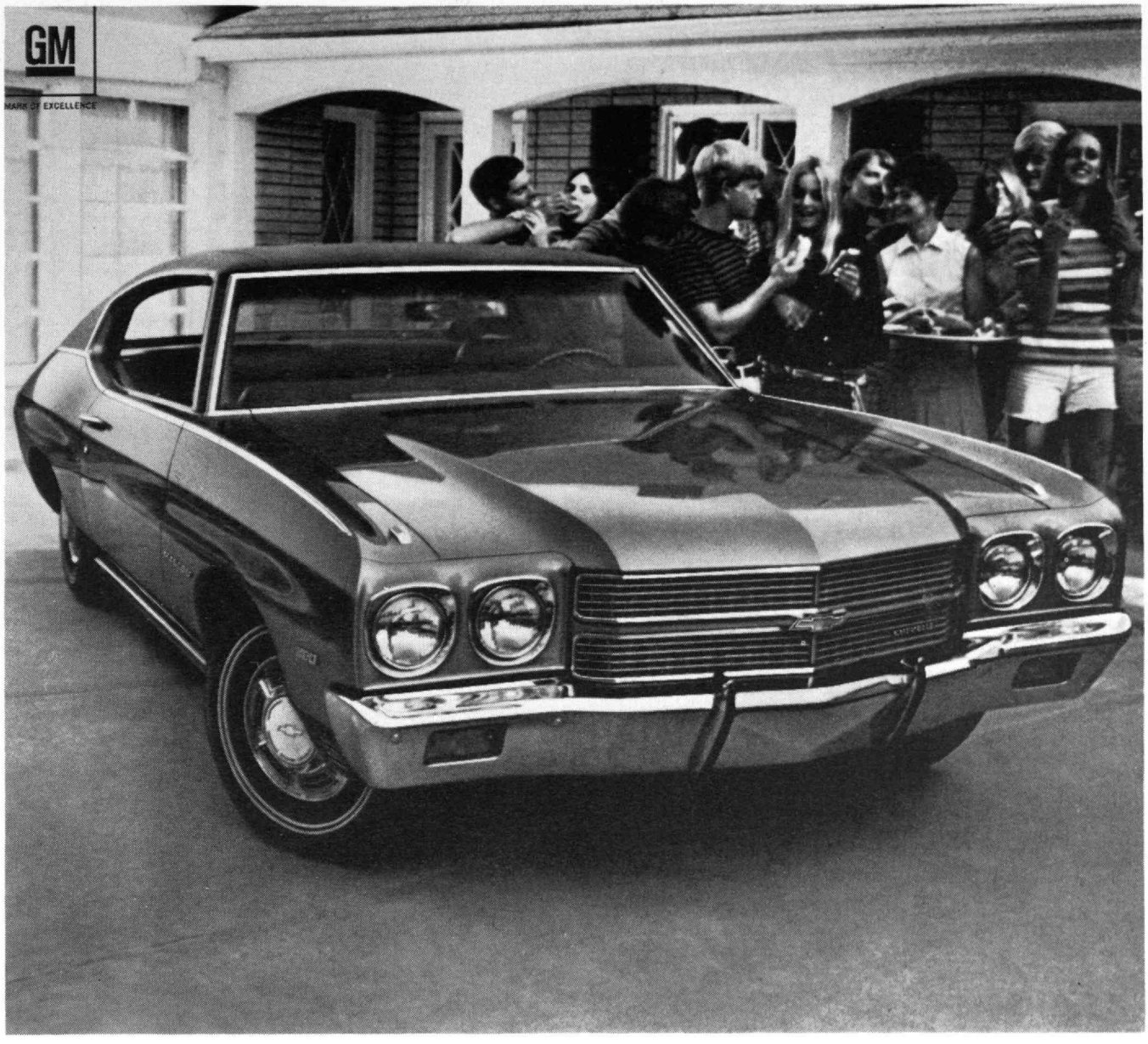
Working in the World

Alan Calavano is a member of the sixth place international barbershop chorus. The Poughkeepsie New Yorkers, of the Society for the Preservation and Encouragement of Barbershop Quartet Singing in America (S.P.E.B.S.Q.S.A.). They have won the right to compete in the 1970 International Competition in Atlantic City where they hope to place 1st or 2nd.

Alan Morr is working with the Reserve Power Department of Bell Labs in Whippany, N.J. . . . **John Sole** is still in Peru building offshore platforms and pipelines for Brown and Root's client, Belco Petroleum Corp. John invites anyone passing through the northern desert of Peru to drop in. He reports that it hasn't rained there in 32 years. . . . **Cliff Henricksen** is a research project engineer with Scott Paper Co. in Philadelphia and recently collaborated with Otto Piene on "Octopus" which was shown at the Howard Wise and Jewish Museums in New York, Yale University, and the Witte Museum in San Antonio. . . . **Harold Granek** has purchased a home in western Massachusetts and is working on a Ph.D. at M.I.T.

Barbara and **Jeff Silverman** are currently living in Chicago along with their shelties Samson and Apricot Brandy II. Jeff is Director for Commodity Research for Woodstock, Inc. and the Chicago Mercantile Exchange. He finds trading pork bellies an exciting and fast way to make a living. . . . **Charles Kochakian** is working at the M.I.T. Draper (I) Lab, is married, and has two boys (six and three). He is also an assistant professor in the evening division of Merrimack College, North Andover, Mass. . . . **Ray Paret** reports that things are going well in show biz. The following albums came out in January: Andy Pratt on Polyder, Bead Game on Avco-Embassy, and Quill on Atlantic-Cotillion. . . . **Howard Ostroff** is employed as a consultant with the Traffic Management Group of Peat, Marwick, Mitchell, Inc. in Washington, D.C. . . . **Phil Weidner** has taken a year off from Harvard Law to "travel, work, and ski." . . . Finally the following exhilarating note from **Jim Lewis:** "Started at 5,600 feet elevation in Owens Valley in the desert, 4 days and 35 miles through the high Sierra, later reached 14,496, the top of Mt. Whitney, felt like the top of the world. Slightly giddy from the altitude—what a way to get high!"

I went to Chicago in December and gave a paper at the National Electronics Conference on a topic that came out of my S.M. thesis. Other than that Gail and I don't have anything else to report this month. How about you?—**Gail** and **Mike Marcus,** Secretaries, Eastgate Apt. 16A, 60 Wadsworth St., Cambridge, Mass. 02142



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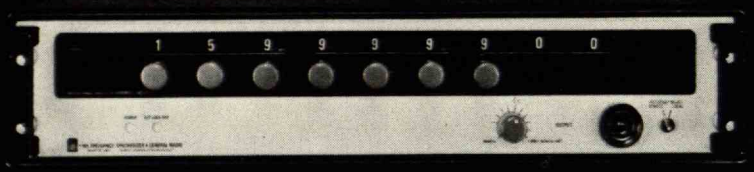

160 MHz for $5900

Buying a frequency synthesizer has been something like buying a car. There's a confusion of models, options, and price ranges. Except – there has never been a so-called "intermediate"-model synthesizer. That's because price and performance ranges of synthesizers have tended to cluster just at both ends of the spectrum. The choice was between lower-cost, limited-frequency-range models and those with everything, including a sky-high price tag. So, the buying decision was one based on either trade-off or over-capability.

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